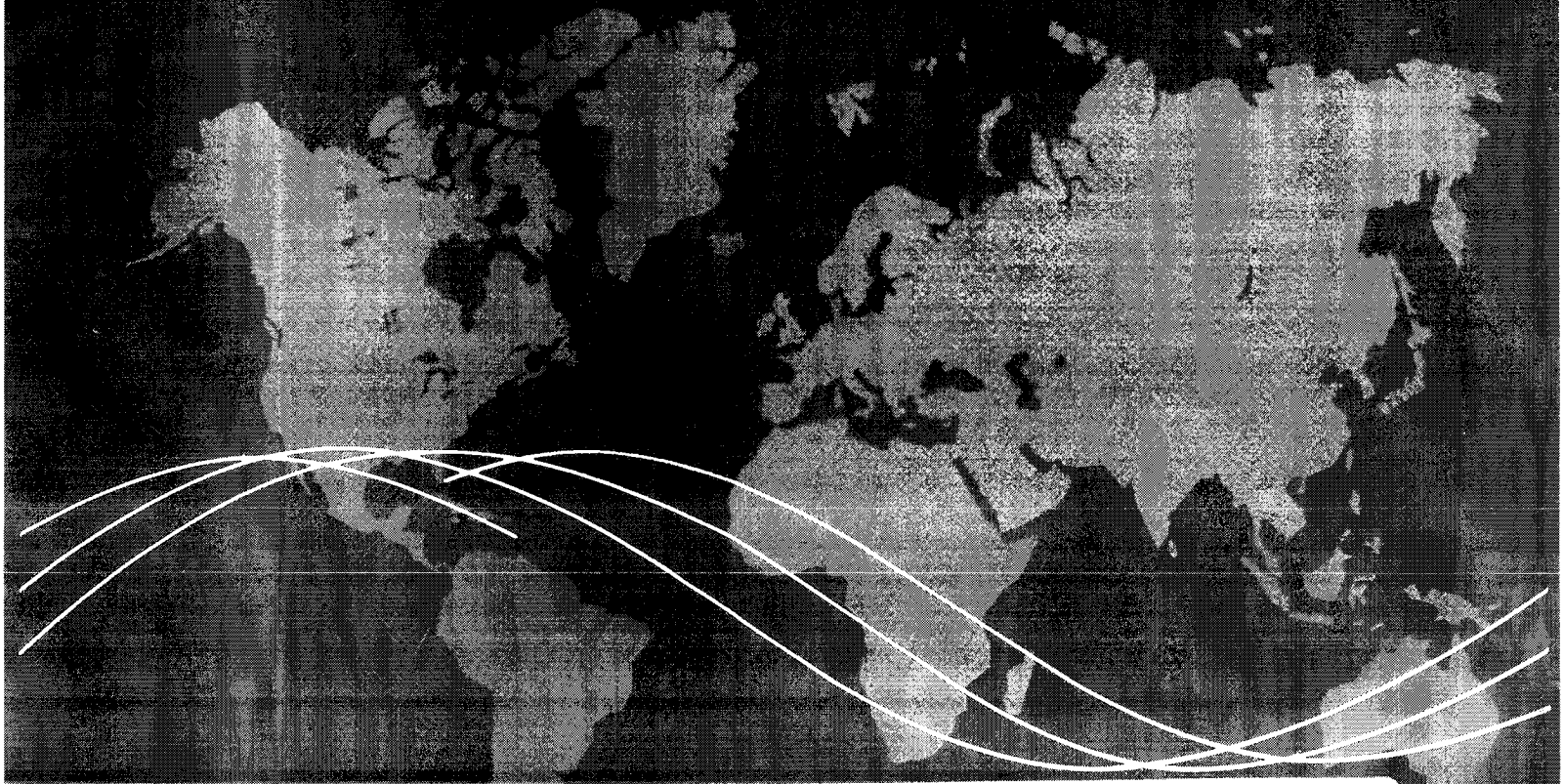
OPERATION AND MAINTENANCE

X-Y RECORDER
MODEL 3010
GODDARD SPACE FLIGHT CENTER



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HANDBOOK OF INSTRUCTIONS FOR MEC MODEL 3010 X-Y RECORDER

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GENERAL DESCRIPTION

1-1. General (See Figure 1-1)

The X-Y Recorder (plotting board) is designed to present a continuous plot of functions by automatically positioning two pairs of pens according to the two variable inputs, X and Y. The plotting surface is located in the upper vertical portion of the board. All operating controls are located on the front sloping surface. However, certain maintenance adjustment controls are located within the cabinet, on their associated chassis. The various electrical chassis are located in the lower portion of the rack. These chassis are accessible through the two doors in the lower vertical part of the equipment.

1-2. Control Unit

The control chassis is located in the center of the sloping front surface directly below the plotting board. The chassis rides on tracks, and can be pulled out for maintenance without disconnecting the wiring. All electrical connections to the chassis are made through two MS3102A connectors. With the exception of scale factor and parallax controls, most Recorder operating controls are incorporated in this chassis. Two reference dual D-C amplifiers (5 and 6, figure 2-1) are integral parts of this chassis.

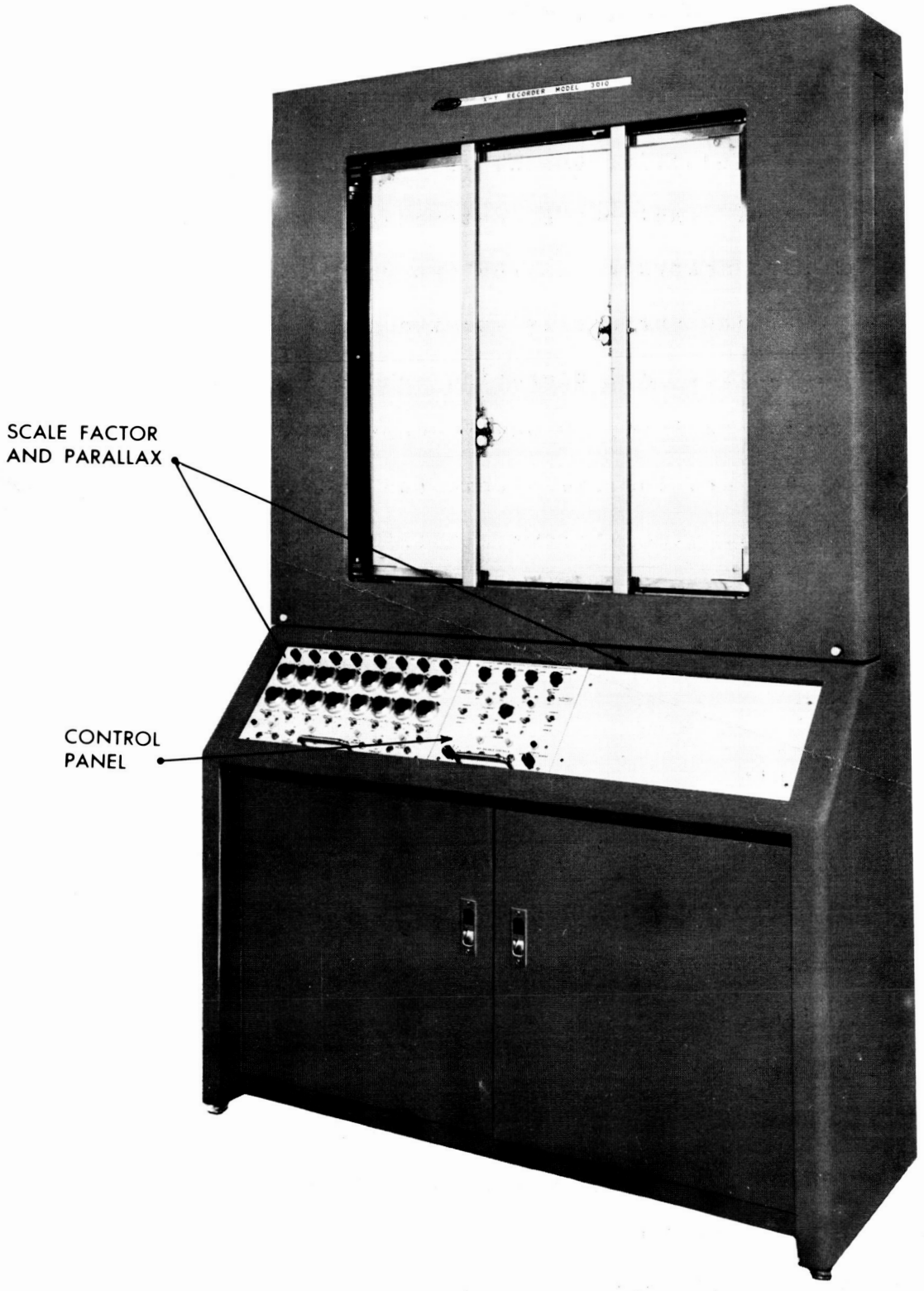


Figure 1-1. X-Y Recorder

1-3. Scale Factor and Parallax Chassis.

The Scale Factor and Parallax Chassis is located on the left side of the control chassis. The necessary d-c amplifiers 1 through 4, figure 2-1 are incorporated in this chassis. Electrical connections to this chassis are made through MS3102A connectors. Each parallax unit incorporates an indicator light, which is on when that unit is operating. A parallax-adjust toggle switch serves to remove the inputs from the circuit when independent parallax adjustment is desired.

1-4. Servo Supply 15-72A (See Figure 1-2)

The Servo Supply is housed in a 14 X 2 1/2 inch chassis, bolted to the bottom of the Recorder cabinet by four retaining bolts. The unit can be removed for servicing by loosening these retaining bolts. The connecting cable is long enough so that this may be done without disconnecting the chassis. The large loop handles enable the chassis to be inverted for servicing without damage to components.

1-5. Power Supply 15-71A (See Figure 1-3).

The 15-71A Power Supply is contained in a 16 X 13 X 2 1/2 inch chassis which is bolted to the bottom of the Recorder cabinet by four retaining bolts. The supply can be removed, without disconnecting the cable, by loosening the retaining bolts.

The loop handles enable the supply to be inverted for servicing without damaging components. All connections to the supply are made through connector MS3102A32-13P.

1-6. Servo Amplifier 15-31A (See Figure 1-4)

The Servo Amplifier is housed on an 8 X 13 X 2 1/2 inch chassis, bolted to the bottom of the Recorder cabinet by four retaining bolts. The amplifier can be removed, without disconnecting the cable, by loosening the retaining bolts. The loop handles enable the amplifier to be inverted for servicing without damaging components.

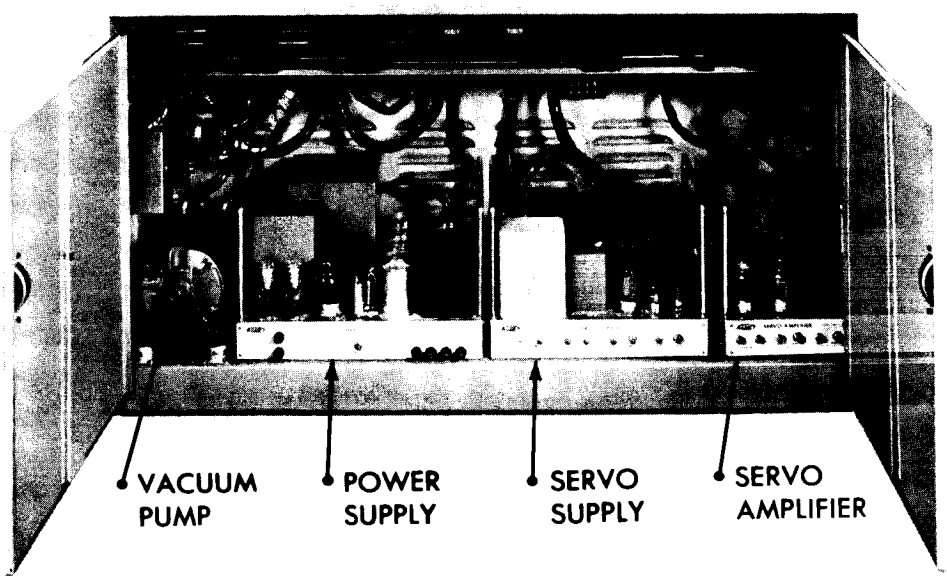


Figure 1-1A. Lower Portion of X-Y Recorder Rack (Showing Enclosed Chassis)

Figure 1-2. Servo Supply

Figure 1-3. Power Supply

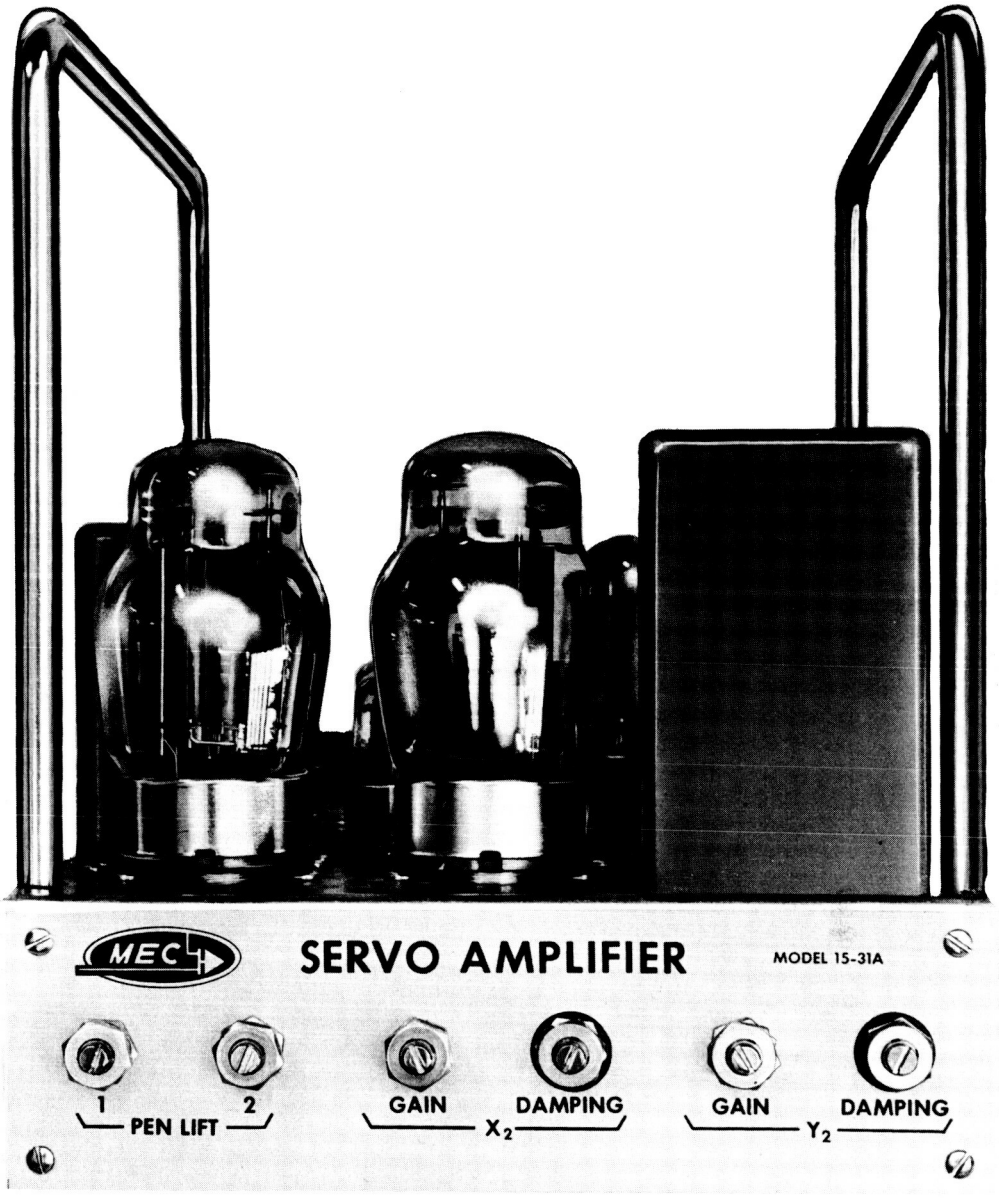


Figure 1-4. Servo Amplifier

SECTION II

THEORY OF OPERATION

2-1. General

The X-Y Recorder is essentially composed of two closed loop servo systems. One system positions the pen (Y plot) and the other positions the arm (X plot) on which the pen moves. The position of the pen at any instant is, therefore, the resultant of the arm and pen positions. The locus of all pen positions (for "f," some function) is a continuous line; i.e., a graph of the function y = f (x).

In addition, the Recorder is capable of performing the following tasks: parallaxing the plot, that is, shifting the origin; changing the scale factor so as to expand or contract the plot without distortion; switching plotted functions from one pen arm to the other; and raising and lowering the pens either manually or automatically.

2-2. Operation (See Figure 2-1)

Each arm and pen operates identically; therefore, only the left arm and pen are described.

The Y_1 signal is applied to the Y_1 scale factor circuit which functions as a multiplier for the Y_1 signal. A parallax voltage, which can be either positive or negative, is added (if desired) to the scaled Y_1 signal. Amplifiers 3, 4, 5 and 6 are part of the scale factor and parallax network. The modified Y_1 signal is routed to the interchange circuit. This

circuit acts as a single-pole double-throw toggle switch which applies the Y_1 signal either to the Y_1 or Y_2 pen Servo Amplifier. Normally, when plotted functions are not interchanged, the Y_1 signal is applied to the Y_1 amplifier, provided the ARM 1 switch is in the OPERATE position. The output of the Y_1 Servo Amplifier drives the servo motor and is also applied to the pen lift circuit. The Y_1 servo motor, while positioning the Y_1 pen, also positions the wiper of the feedback potentiometer which applies feedback voltage to the Y_1 Servo Amplifier. The effective input to the Y_1 Servo Amplifier is the resultant of the signal and feedback voltages. The Y_1 servo motor constantly drives the feedback potentiometer to produce a feedback voltage equal to the signal voltage, at which point the motor, pen and potentiometer will be at rest.

Amplifiers 5 and 6 produce positive and negative reference voltages which are distributed to all feedback potentiometers and parallax circuits. The parallax switches apply either the negative or positive voltage to their associated circuits. The polarity of the applied reference controls the direction of parallax.

The outputs of the Servo Amplifiers have the secondary function of controlling the pen lift circuits. In the automatic mode of operation, any extremely large resultant input to the Servo Amplifier causes the pens to raise. This function prevents unwanted marks on the tracing paper, since the large resultant causes the servo motor to slew. A large resultant input

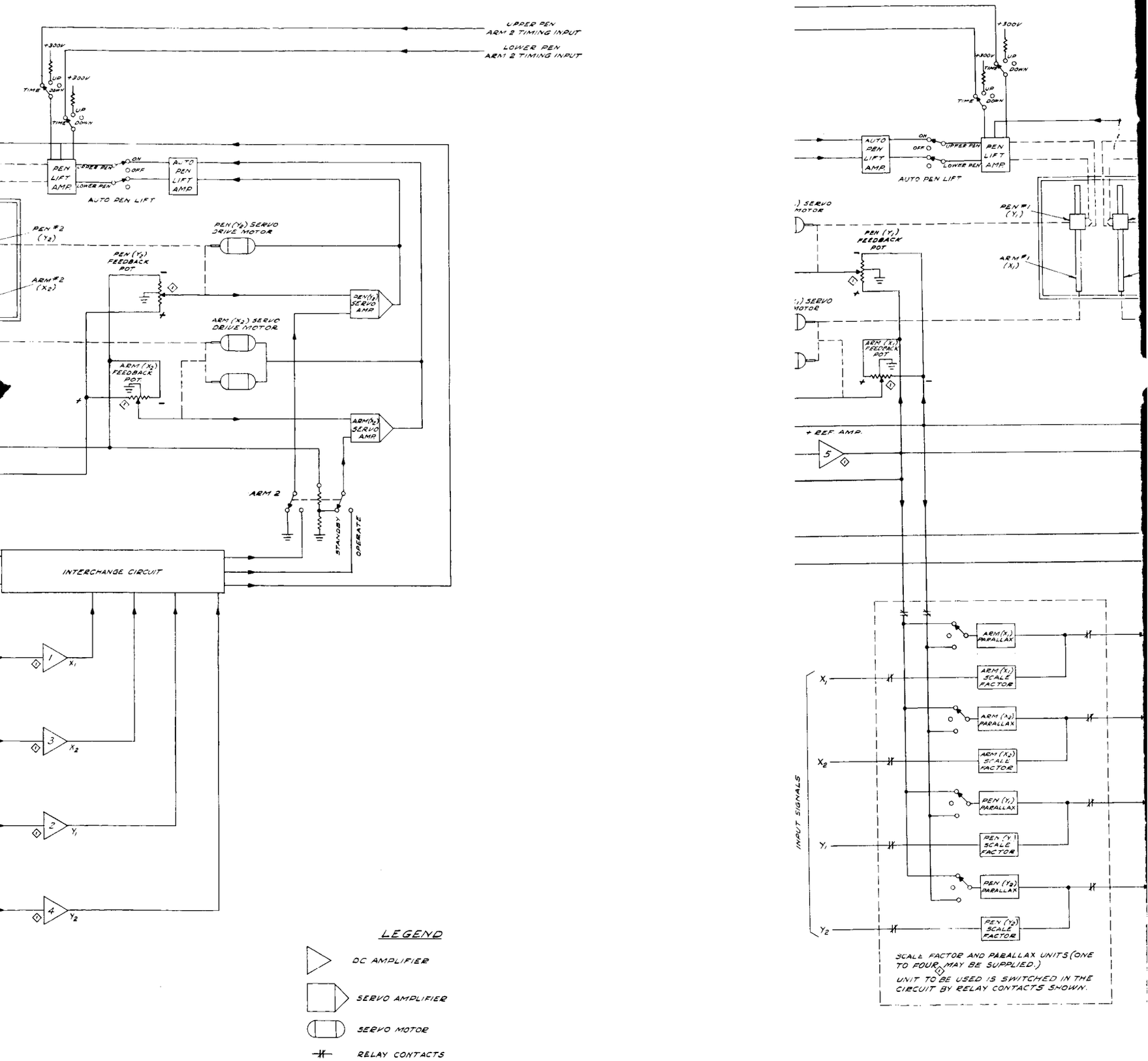


Figure 2-1.
Block Diagram X-Y Recorder

(produced by a sudden change of signal input) causes a large output of the amplifier. When such a large output is applied to the pen lift circuit the associated pen is raised by relay action. When the ARM 1 switch is in the OPERATE position, input signals are applied to the Servo Amplifiers. When the switch is placed in STANDBY, signal input is removed, and amplifier signal input grounded. The entire feedback voltage is hence felt at the amplifier input. The high output applied to the auto pen-lift amplifier actuates the circuit to raise the pen when the auto pen feature is used. Simultaneously, the motor slews to drive the feedback potentiometer wiper to the ground position. The right hand pole of the ARM 1 switch applies a negative voltage to the X1 servo amplifier which is approximately equal to the servo reference voltage. This causes the arm to slew to the extreme left side of the board. Since a grounded input to the Y1 amplifier corresponds to the central pen position, and the negative input to the X1 amplifier corresponds to the extreme left arm position, the STANDBY position of the ARM 1 switch causes the pen to move to the center of the arm and drives the arm to the left side of the plotting surface.

The main difference between the X and Y channels is that the X channel has two servo motors whereas the Y channel has one. This is because the arm is heavier than the pen.

2-3. Control Unit (See Figure 7-2)

With the exception of the Scale Factor and Parallax controls, most Recorder operating controls are located on this unit. The

following paragraphs (2-3.1. through 2-3.8.), describe the functions of these controls.

2-3.1. Filament Power Switch

This switch has three functions. It controls filament power for the entire unit; applies voltage to back lighting powerstat T201; and energizes the supply sides of the plate switch,S201, and vacuum pump phase switch S203. Two phases are supplied to switch S202 so the Recorder can operate with 120 volt single phase, 120/240 volt single phase, or two phases of a three-phase 120 volt system. When the FILAMENT switch is closed amber indicator DS202 lights. Phase 1 power is applied to terminals D and L. Power to terminal L is regulated by powerstat T1 which controls light brightness. Plate power cannot be applied prior to filament power. If filament power is removed, plate power also is removed.

2-3.2. Plate Switch

The PLATE switch controls the application of all dc plate power in the Recorder. Application of plate power energizes red indicator lamp DS201. Phase 2 power is applied to terminal E.

2-3.3. Vacuum Switch

The VACUUM switch applies power to the vacuum pump which creates the vacuum which holds the tracing paper against the plotting surface. The FILAMENT switch energizes the supply side of the VACUUM switch. When the VACUUM switch is placed in the ON

position, phase 1 power is applied to terminal F.

2-3.4. Back Lighting Control

Powerstat T1 controls the brilliance of chart back lighting by varying the voltage across the chart incandescent lamps.

2-3.5. Pen Control

2-3.5.1. Manual Pen Control

Two switches are associated with each pen. Each of the ARM 1 PENS switches, for instance, raises and lowers its pen and selects an external time signal to be applied to the pen. The AUTO PEN LIFT switches control application of the automatic pen lift to their associated pens. The pens themselves are controlled by circuits located in the Servo Supply and Servo Amplifier chassis. These circuits are, in turn, controlled by voltages from terminals T, j, c and a of the Control Unit. Normally, the pens go down if no voltage is applied to these terminals and are raised upon application of a positive voltage. The control voltages are applied through resistors R203 through R206. The source is the +300 volt regulated supply. The extreme left-hand switch contacts enable injection of timing marks, from an external source, into the pen control circuits. The timing inputs are applied to terminals R, V, W and Y.

2-3.5.2. Automatic Pen Lift

Automatic pen lift voltage is applied by switches S208 through S211. The switches receive signals from rectification circuits

across each servo amplifier output transformer. When the voltage output exceeds a preset value, as determined by a servo chassis adjustment (refer to paragraph 2-6.4), the pens are raised independently. Diodes CR201 through CR208 prevent circuit interaction. Diodes CR209 and CR210 cause the pens to lift when ARM 1 switch S212 is placed in the STANDBY position. The diodes sense +300 volts applied through resistor R211 and the upper set of contacts of S211. Switch S212's STANDBY position removes the X_1 and Y_1 output signals of amplifiers 1 and 2 from the X_1 and Y_1 servo inputs.

2-3.6. Standby Switch

A STANDBY switch is associated with each arm. When the switch is in the OPERATE position, the associated arm and pen plot the applied function. In the STANDBY position, the switch causes the associated pen to move to the center of the arm and the arm to move to one side of the board. For instance, when switch S212 is placed in the STANDBY position, the X_1 and Y_1 output signals of amplifiers 1 and 2 are removed from the X_1 and Y_1 Servo Amplifier inputs. The X_1 Servo amplifier input then changes to divider resistors R207 and R209 causing the arm to move to the edge of the board. The Y_1 servo input is tied to ground and the pen moves to the center of the arm. Switch S213 functions similarly for Arm 2.

2-3.7. Pen Interchange Control

This circuit controls routing of plotted functions to arm and

pen 1 or 2. When the INTERCHANGE switch is in the NORMAL position, X_1 and Y_1 signals are plotted on arm 1, and X_2 and Y_2 signals are plotted on arm 2. When the switch is in the REVERSE position, X_1 and Y_1 signals are plotted on arm 2 and X_2 and Y_2 signals are plotted on arm 1. When the switch is placed in the AUTOMATIC position, the arms plot according to which function is to the right or left of the other. Interchange does not reverse trace color, timing or other plot characteristics. Relays K201, K202 and K203 control pen interchange according to the position of the INTERCHANGE switch. In the NORMAL position, relays K201 and K202 are de-energized and X_1 and Y_1 signals are applied to the X_1 and Y_1 Servo Amplifier inputs. Also X_2 and Y_2 signals are applied to the X_2 and Y_2 amplifiers. If the INTERCHANGE switch is placed in the REVERSE position the input lines to the Servo Amplifiers are effectively switched. Whenever K202 is energized, relay K201 is energized, all pen plotting signals in arm 1 are switched to arm 2; and arm 2 signals switched to arm 1.

2-3.8. Input Selector

The INPUT SELECTOR switch, S214, selects a scale factor and parallax circuit. In the #1 position this switch energizes relays in Scale Factor and Parallax unit #1 causing that unit to be connected to the plotting circuit. Other units may be similarly energized. This switch can be placed in the remote

(R) position in which case a similar switch or relays at a remote point may be used to select scale factor and parallax circuits. Raising and lowering of the pens may also be controlled remotely by switching the required pen switches (S204 through S207) to the TIME position and connecting the control signals to leads R, V, W and Y.

2-4. D. C. Amplifiers

Since both amplifiers in a chassis are identical, only Amplifier #1 of Figure 7-2 is described.

The input signal is applied to the grid, pin 2 of tube V1. The amplified signal is directly coupled to the grid, pin 7 of V2a, and again amplified. The signal is then directly coupled to the grid, pin 2, of V3a, then to the grid, pin 2, of V2b, whose cathode provides the output. The ac section of the amplifier is a drift stabilization circuit which compensates for slow changes in various circuit parameters. This section senses an error signal, amplifies, rectifies and filters it, and reapplies it to the dc section so as to maintain a constant null voltage resultant at the input, or summing point. The input is called the summing point because it is here that the feedback and input voltages add algebraically to produce the null voltage, or offset.

2-4.1. AC Section

The offset voltage is applied to contact 2 of chopper K51A, and coupled as a square wave signal to the grid, pin 1, of tube V4.

The amplitude of the signal is a function of the magnitude of the offset and the phase of the signal is a function of the polarity of the offset. Tube V4 amplifies the signal and couples it, through capacitor C4, to the grid, pin 1, of V5. The output of V5 is filtered by resistor R28 and capacitor C8. The resulting dc output of this filtering network is the control voltage which corrects excessive offset. This control voltage is reapplied to the first stage of the dc section, at the grid, pin 7, of V1.

2-4.2. Balance

If the offset voltage is too large, the error signal at pin 5 of V5 is sufficient to energize neon lamp DS1. The lamp indicates overloading of the ac section of the amplifier. Overloading can be corrected with the aid of pushbutton S1. This pushbutton, when pressed, short-circuits the control voltage output to pin 7 of V1, removing the correction to the dc section. When potentiometer R7 is varied, bias on tube V2a is varied which, in turn, varies the output voltage and the offset voltage. This bias can be varied so that the offset voltage is decreased to a point where DS1 de-energizes. When pushbutton S1 is then released, the reduced output of the ac section is reapplied to pin 7 of V1. The ac section, now no longer overloaded, further reduces the offset to its normal operating range, whence the circuit functions as described in paragraph 2-4.1.

2-4.3. Circuit Details

Tube V1 operates across the + and - 300 volt supplies. Its cathode is at approximately 1 volt. Diode CR1 and divider network R63 and R64 prevent cathode voltage from being raised too far above this level when a large positive signal is applied to the input. Otherwise the circuit would be bi-stable and would not recover. The plate, pin 6, of this tube is held at approximately the same voltage as the plate, pin 1, by resistor divider networK R2 and R4. Due to the magnitude of plate currents and the 8 volt instead of the usual 12.6 volt filament supply, grid currents in this stage are extremely low. This characteristic reduces offset.

Resistor R61 and capacitor C1 form the cut-off network for the amplifier. The output stage, V2a and V3a, is connected in a configuration known as a Peterson Amplifier circuit. The tubes are in series across the + and - 300 volt supplies. The plate signal of a V3a is directly coupled to the grid of V2a. Grid bias for V2a is produced by the IR drop across R13. As the grid of V3a is driven more positive, the plate will be driven below ground potential causing greater current to flow between the two supplies. The increased current increases the IR drop across R13, establishing increased bias on V2a, which results in a net reduction in overall current change. If a load is connected to the output circuit, bias change on V2a will be more rapid for a given bias change on V3a. Hence, for negative going output excursions, current drawn from the +300 volt supply will decrease in proportion to the negative output excursion. If the bias on V3a is made more negative, plate voltage rises;

the IR drop across R13 decreases which decreases bias on V2a. This decreased bias enables V2a to provide sufficient current to produce the positive output excursion. This output stage, although requiring two tubes, greatly reduces power supply requirements to drive a given load.

Rectifier CR2 limits the negative voltage that can appear across capacitor C8; the grid of V1 limits the positive voltage.

Output voltage excursion is limited by the network consisting of rectifiers CR5, CR6 and resistors R57 and R60. Each diode is biased at cutoff when the output of the amplifier is zero. Cutoff bias is produced by the reference voltages in conjunction with the voltage dividers. The diodes do not affect the operation of the amplifier when they are cut off. When the output voltage exceeds the positive reference voltage by a small amount, diode CR6 conducts. Since it is effectively in parallel with the amplifier feedback resistor, it will limit the amplifier output to slightly more than the reference voltage. Diode CR5 functions similarly to limit negative output excursions.

2-5. Scale Factor and Parallax Unit (See Figure 7-2)

The Scale Factor and Parallax Unit enables adjustment of each of the four variables (X_1, X_2, Y_1 and Y_2) to be recorded on the plotting surface. It is also possible to change the origin of the plot to any portion of the plotting surface or to within any area off the plotting surface of equal width to the plotting

surface.

Input signals are applied to pins X, Y, Z or a. Since the unit is composed of identical circuits, only a typical input, at a, is described.

2-5.1. Scale Factor

The signal voltage at pin a is applied through relay K2 contacts 1 and 11 to the divider consisting of resistors R202 and R203. Resistor R203 is the scale factor adjustment potentiometer. Its output is applied to switch S202. Switch S202 applies the output to one of three dc amplifier input resistors. These resistors define a general scale factor range. The potentiometer varies dc amplifier gain within this range, hence, acts as a vernier for switch S202. The switch positions, LOW, MED and HIGH indicate the degree of expansion of the plot.

2-5.2. Parallax

Potentiometer R201 controls parallax amount. Parallax direction is controlled by selectro switch S201. This switch selects either + or - reference voltage for potentiometer R201. The amount of parallax can be determined by the numerical ratio between

the d-c amplifier feedback resistor (R229) and the parallax input resistor (R207) (See figure 2-2). The value thus determined expresses the maximum number of board widths available. Relay K1 connects the scale factor and parallax circuitry to the plotting circuitry. Each scale factor and parallax circuit incorporates a similar relay. Selection of the desired scale factor and parallax circuit is determined by these relays.

2-6. Servo Supply 15-72A (See Figure 7-4)

The Servo Supply chassis contains circuits which produce the following three main outputs:

a. 400 cycle reference power for a maximum of six servo motors.

b. Two servo amplifier outputs, associated with the pen and arm drive servos for the left-hand arm (arm number 1) of the X Y Recorder.

c. Pen lift control signals for the timing and writing pens.

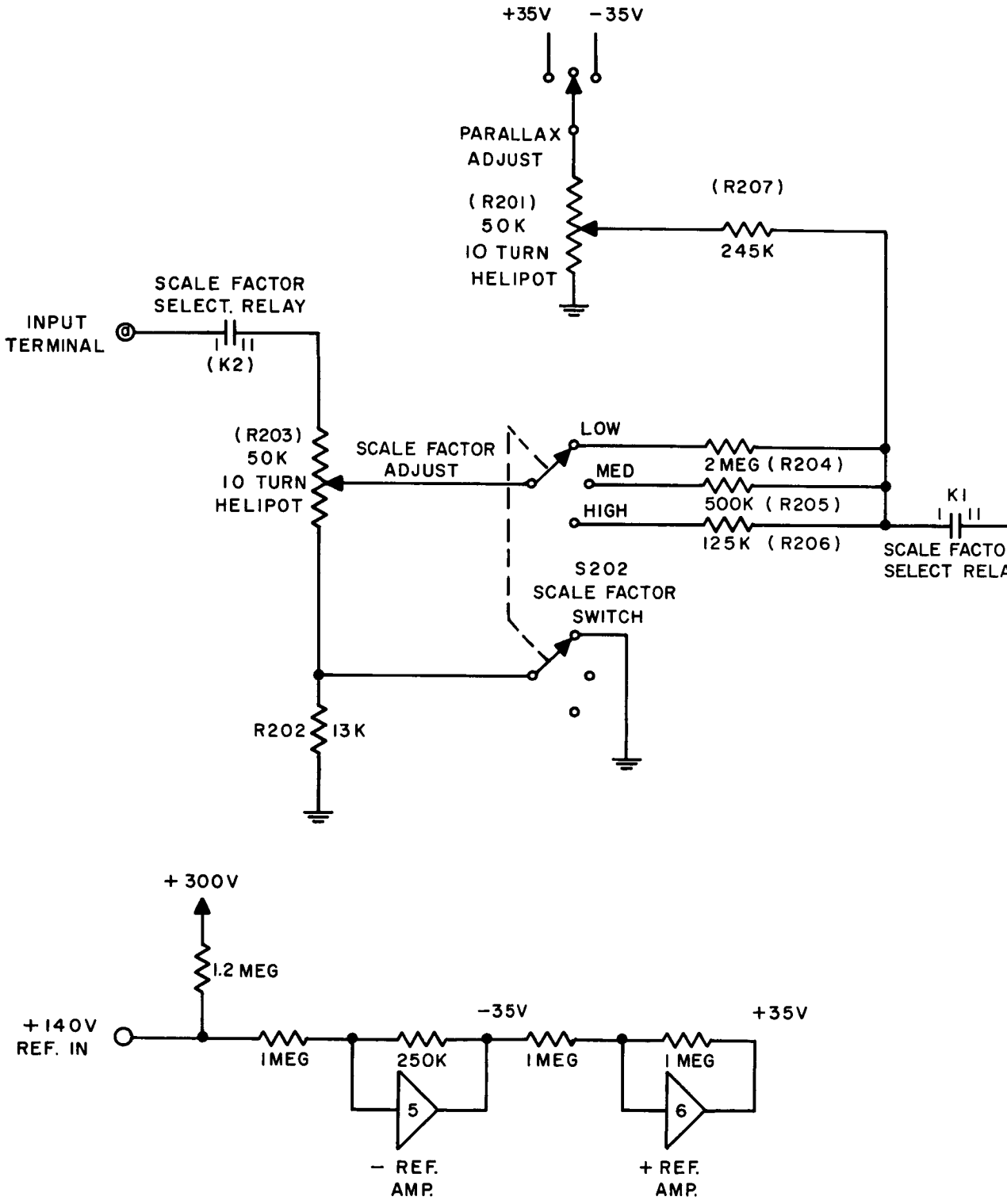
2-6.1. 400 Cycle Exciter Section

This section consists of tubes V9 through V15 and supplies 400 cycle reference power to the servo motors. Tube V9 is connected as a Colpitts oscillator. Split capacitor C13A and C13B, in the LC resonant circuit, produces the feedback. The output of the oscillator is coupled through R44 and gain control potentiometer R45 to the grid, pin 2 of tube V10a. The output is

amplified and coupled directly to the grid, pin 7, of phase splitter V10b. The two outputs of V10b drive cathode followers V11a and V11b 180° out of phase. The outputs of the cathode followers are directly coupled to the grids of push-pull power output tubes V12 through V15 which are connected for Class B operation. Bias for Class B operation is determined by the cathode bias values for cathode followers V11a and V11b. Normally, the junction of resistors R54 and R91 is at -65 volts. This establishes -45 volts on the cathodes of V11a and V11b which produce the grid drive power for Class B operation of the output tubes. The output tubes, V12 through V15, produce the reference phase for the servo motor windings via output transformer T5. The primary of this transformer and capacitor C20 form a resonant circuit which improves the output waveform characteristics. Two negative feedback paths are utilized. One is taken from pin 3 of transformer T5 and coupled through resistor R52 to the plate of tube V10a. The other is taken from pin 6 of T5 and coupled through R53 to the cathode of V10a. Resistor R92 and capacitor C17 form a cut-off network which prevents oscillations caused by the feedback loops.

2-6.2. Servo Amplifiers

The amplifier section of the chassis is composed of tubes V1 through V7. Both arm and pen Servo Amplifiers are practically identical, hence only the upper portion of Figure 7-3 (the arm servo) is described here. The following are the main differences between the two Servo Amplifiers: the upper (arm) servo drives


+35V
-35V
PARALLAX ADJUST
(R201) 50K 10 TURN HELIPOT
(R207)
245K
SCALE FACTOR SELECT. RELAY
INPUT TERMINAL
(K2)
(R203) 50K 10 TURN HELIPOT
SCALE FACTOR ADJUST
LOW
MED
HIGH
2 MEG (R204)
500K (R205)
125K (R206)
K1
SCALE FACTO
SELECT RELA
S202 SCALE FACTOR SWITCH
R202 13K
+300V
1.2 MEG
+140V REF. IN
1MEG
250K
-35V
1MEG
1 MEG
+35V
5
6
- REF. AMP.
+ REF. AMP.

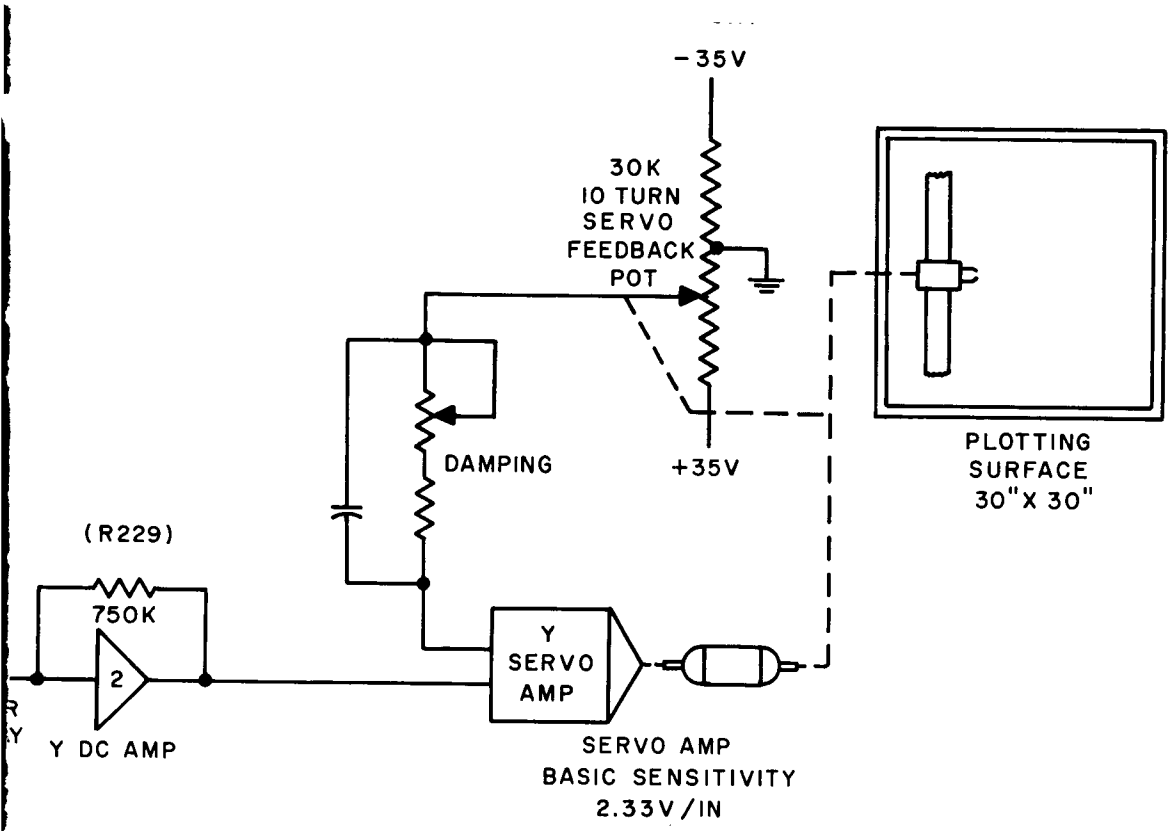


Figure 2-2. Signal Flow Diagram, X-Y Recorder

a pair of servo motors whereas the lower (pen) servo drives only one; the arm servo has two 6550 push-pull output tubes whereas the pen servo has two 5881 push-pull output tubes; servo damping network capacitors C21 and C22 differ slightly because of the different mass of pen and arm; output transformer and resonating capacitors C6 and C12 differ slightly; and finally, biasing the push-pull output stages is accomplished in a slightly different manner. The theory of operation is, however, identical in each case.

2-6.3. Arm Servo Amplifier

Input signals are applied to terminal c and feedback signals to terminal w. Error between these signals establishes a voltage across resistor R3. This dc error is chopped by converter K1 and applied to input transformer T1. Resistors R3, R61, R62 and capacitor C21 form a damping network. The ac error signal at pin 4 is amplified by both halves of V1 and applied, through gain control potentiometer R9, to the grid, pin 2, of tube V2a. The output V2a is directly coupled to the grid, pin 7, of phase splitter V2b. Tube V2b drives Class AB1 power output tubes V3 and V4 180° out of phase. The power tubes drive the primary of transformer T2 which, in turn, drives the control phases of the arm servo motors. The primary of T2 and capacitor C6 form a resonant circuit which improves the output waveform characteristics. Feedback is taken from two sources; from pin 3 of T2 and applied to the plate of V2a, and from pin 7 of T2 and applied

to the cathode of V2a. Output tubes V3 and V4 are biased by a combination fixed and cathode bias derived from resistors R86, R87 and R16.

2-6.4. Automatic Pen Lift Control

The automatic pen lift control circuit, tubes V16 and V17, provides control voltage to the pen coils of the arm number 1 writing pens. The circuit automatically raises the pen when either the arm or pen carriage slews. This prevents the chart from becoming unnecessarily marked. The operation of both tubes is identical, hence only V16 is described. Pin 7 of V16 is normally held at -300 volts from terminal Z. The lower half of the tube is hence cut off; no current flows through cathode resistor R72; there is no bias on the upper half, and it conducts heavily through resistor R73 and the pen coil. When current flows through the pen coil the pen is lowered. When a positive signal is applied to terminal b the lower portion of V16 conducts, due to the proportions among resistors R68, R69 and R70. When this portion conducts, current flows through resistor R72, establishing negative bias at pin 2, cutting off the upper portion. Consequently, the plate, pin 6, of the lower portion, moves toward ground, reducing the current in the pen coil to almost zero, at which time the pen is raised. Resistor R67, between the pen coil and the negative supply insures that current in the pen coil actually does go to zero after the pen is raised. The diode associated with the pen coil keeps terminal X (voltage across pen coil) from becoming negative. Automatic control of the pen lift circuit is

provided by terminals B and M which are connected to the outputs of the pen and arm Servo Amplifiers. The signals appearing at these outputs are rectified by CR1 and CR2 which develop a dc voltage across capacitor C23. This voltage is applied to terminal b via K3 and pen switch in control panel and raises the pen whenever a slew (high Servo Amplifier output voltage) occurs. Tube V17 functions identically to V16. Selector switches on the Control Panel can be used to apply timing signals to the grids of the pen lift tubes to timing marks on the pen trace. Transformer T6 supplies filament power to various tubes in the Servo Supply as well as other Recorder circuits.

2-7. Power Supply 15-71A (See Figure 7-4)

The 15-71A Power Supply supplies all regulated and unregulated dc voltages for the Recorder, associated computing amplifiers and a large percentage of filament power. The two input transformers, T1 and T2, are energized by two 120 volt 60 cycle sources.

NOTE

All transformers are in compliance with Mil-T-27, Grade 1.

One, filament power, is connected to terminals N and C. The other, plate power, is connected to terminals A and N. Terminal N is the common terminal. Terminals A and C are "hot." Power can be taken from a single phase 120 volt circuit, a single phase 120-240 volt circuit or any two phases of a 120

volt three phase circuit.

Transformers T1 and T2 are protected by a 10 ampere fuse and a 2 ampere fuse, respectively. The fuses are denoted as F1 and F2. Pins 2, 3 and 4 of each transformer compensate for various line voltage conditions. Transformer T1 supplies power for the following dc outputs:

a. +450 Volt Unregulated

b. +300 Volt Unregulated

c. +300 Volt Regulated

d. -300 Volt Regulated

e. -450 Volt Unregulated

Transformer T2 supplies power to regulator tubes V1 and V2, as well as certain circuits outside the supply, via connector pins E through J. Fuses F3 through F6 protect rack wiring in case of filament short circuits.

2-7.1. +450 Volt Unregulated Output

The output of transformer T1 is applied to full wave rectifier CR1 (A and B), and filtered by the LC network formed by inductor L1, and two capacitors C1 and C2. The output of this filter is applied directly to pin M as the +450 volt output.

2-7.2. +300 Volt Unregulated Output

Resistors R1 and R2 form a bleeder network from which is derived the +300 volt unregulated output applied to pin X.

2-7.3. +300 Volt Regulated Output

This output is derived from the +450 volt unregulated output. The +450 volt unregulated output is filtered a second time by the RC network consisting of R3, R5 and R6; C3 and C4. Resistors R5 and R6 establish equal IR drops across capacitors C3 and C4. Since the plate of V1 is connected directly to the output of this filter, its voltage is held constant. The grid, pin 5, of V1 is tied to the plate of V2. Regulator V2 derives its reference grid signal from the wiper of potentiometer R10 which is part of the voltage divider formed by R9, R10 and R11. This voltage divider is between the + and - 300 volt regulated outputs. Potentiometer R10 adjusts the level of the error signal between the +300 volt output and the reference signal. Any error signal felt at the wiper of the potentiometer is applied to the grid, pin 1, of regulator amplifier V2, amplified, and applied to the grid, pin 5, of series regulator V1. This signal controls tube current and hence regulates the +300 volt output taken from the cathode of V1 and applied to pin Y.

2-7.4. -300 Volt Regulated Output

This output is derived from the -450 volt unregulated output. The -450 volt rectified and filtered output of transformer T2 is filtered again by the RC filter formed by resistor R14 and capacitor C8. This voltage is applied, via resistor R20, to 150 volt series regulator tubes V3 and V4 which provide the constant -300 volt output applied to pin V.

2-7.5. -450 Volt Unregulated Output

Silicon rectifiers CR2 through CR5 provide full wave rectification of transformer T1's output. This output is filtered by the LC network composed of inductor L2, and capacitors C6 and C7. The output of this filter is applied to pin K as the -450 volt unregulated output.

2-7.6. Grounding Systems

The following three grounding systems are provided: regular and chassis; power (which applies mainly to Servo Amplifiers); and a high quality ground (HQ) which is used in the computing amplifier circuits. The power and HQ grounds are tied together within the Power Supply.

2-8. Servo Amplifier (See Figure 7-5)

The automatic pen lift circuit and arm and pen Servo Amplifiers in this unit are identical to those contained in the Servo Supply, described in paragraphs 2-6.3 and 2-6.4. The only difference between this unit and the Servo Supply is the inclusion of an automatic pen interchange circuit in the former. This circuit is shown in the lower portion of Figure 7-6. The output of the circuit controls relays in the Control Unit. The Control Unit relays, described in paragraph 2-3.7, effect pen interchange. The circuit shown in Figure 7-6 senses the difference in magnitude and polarity of X input signals applied to arms 1 and 2. As long as the X input signal on arm 2 is more positive than the signal on arm 1, the two arms will not collide. If these respective polarities were reversed,

however, the arms would tend to collide, were it not for the corrective action of the pen interchange circuit. The circuit senses this critical polarity relationship and causes arm 1 to plot arm 2's function and arm 2 to plot arm 1's function.

Hence, as the two arms approach each other and reach the critical collision point, their functions are switched and the two arms recede, each now plotting the other's functions. This switching of functions is accomplished by Control Unit relays.

X_1 and X_2 signals are applied to terminals e and f, respectively, and filtered by corresponding RC filter networks composed of resistors R65 and R66 and capacitors C15 and C16. The resultant dc voltages are applied to pins 1 and 6 of 400 cycle chopper K3. The output at pin 7 is a 400 cycle square wave whose amplitude is a function of the difference between the signals applied to pins 1 and 2 and whose phase is a function of the polarity of pin 1 with respect to pin 2. The square wave is coupled through capacitor C17 and amplified by tube V11a. The amplified signal is coupled through C18, subjected to positive and negative limiting by diodes CR5 and CR6 and amplified again by V11b. The amplified signal is applied to phase-sensitive detector V12. The plate supply of V12 is the same 400 cycle supply applied to chopper K3. Since the signal on the grids, pins 2 and 7 of V12, must be either in phase or 180° out of phase with the signal on the plate, pins 1 and 6, V12 is either conducting (grids and plates in phase) or cut off (out of phase). Relay K4 is in series with the plates and is

energized by tube current and de-energized when V12 is cut off. Under normal conditions K4 is unenergized. When X_1 voltage is more positive than X_2 voltage the grids and plates of V12 are in phase and the tube conducts for each half cycle. The 200 pps current pulses through the coil are smoothed by capacitor C23 and energize the relay. Energization of the relay initiates the interchange of functions between the pens.

SECTION III

INSTALLATION AND ADJUSTMENT

3-1. Servo Supply 15-72A

Inductor L1 in the resonant circuit of the exciter Colpitts oscillator should be adjusted, as necessary, for an oscillator output of 400 cps. The Servo Amplifier gain and damping controls and the reference gain control are located on the front panel of the unit. (See Figure 1-2). There are, in addition, two controls for adjusting the threshold level of the automatic pen lift circuits. Perform the adjustments as follows:

a. Adjust the SERVO reference adjust control until neon lamp DS1 lights. Check that this control is adjusted for the minimum gain at which the lamp remains lit.

b. Adjust the Y servo amplifier GAIN control until the pen carriage begins to oscillate, then reverse the rotation of the control until oscillations cease.

c. Adjust the DAMPING control by applying a small step function and noting the Recorder plot overshoot. Adjust for critical or very slight underdamping (slight hunting).

NOTE

If it is necessary to rotate the damping control through a large arc, the gain control should be readjusted, as there is some slight interaction.

d. Adjust the X servo GAIN and DAMPING controls similarly.

e. Adjust the automatic PEN LIFT circuit threshold

control by manually displacing the pen carriage 1/16 to 1/8 inch from its normal null position and varying the threshold control until the pen lifts when this displacement occurs.

3-2. Power Supply 15-71A (Installation)

The primaries of transformers T1 and T2 are usually connected at pins 1 and 3. However, the "hot" lead should be connected to pin 2 to compensate for low line voltage conditions, and to pin 4 for high line voltage conditions.

3-3. Power Supply 15-71A (Adjustment)

The only adjustment necessary is in the +300 volt output circuit. This adjustment is controlled by potentiometer R10. Once it is set no further adjustment should be necessary except when tubes are replaced.

3-4. D. C. Amplifiers (See Figure 3-1)

The gain of the stabilizer portion of the amplifier circuits is sufficiently high so that rebalancing the amplifier should not be necessary unless a component has been replaced.

NOTE

The possible exception to this rule is that it may be necessary to rebalance once during the first 60 hours of operation after replacement of a 5965 input tube.

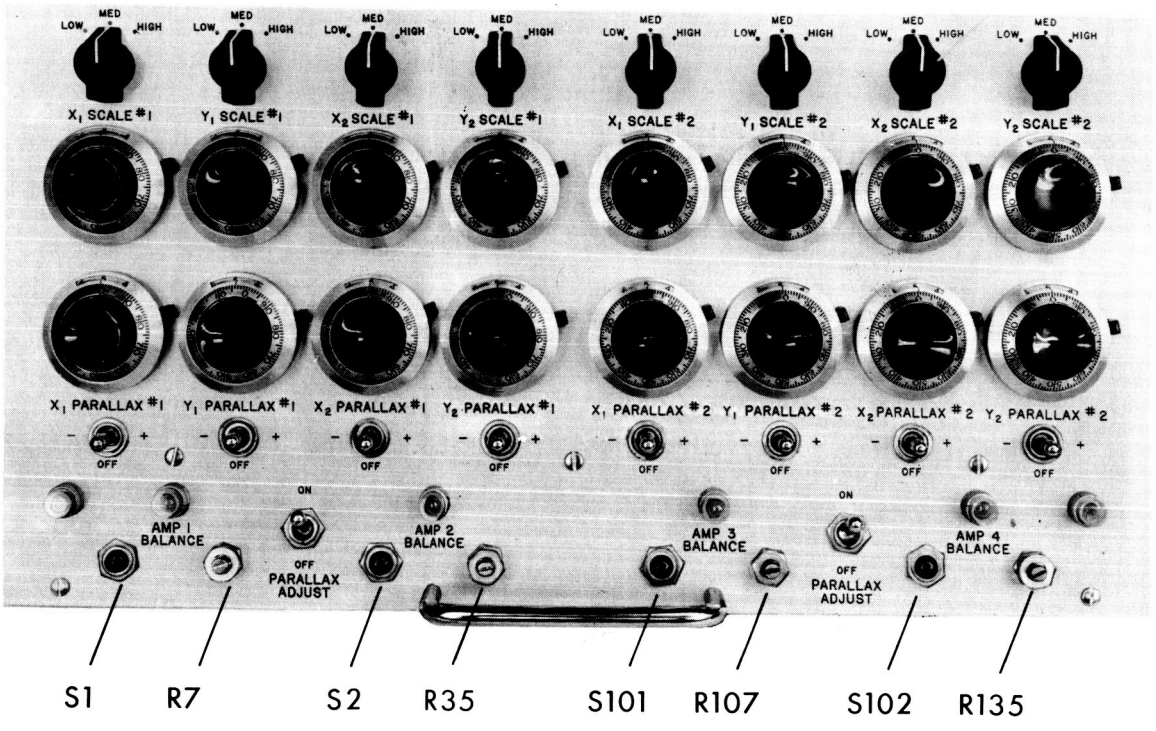


Figure 3-1. D.C. Amplifier Adjustment.

3-5. Refilling the Ink Wells

a. Fill the bulb of the filling needle with the required color of ink.

NOTE

The ink bottles with filling needles are located in the right side of the plotting board cabinet.

b. Fill the required well approximately 3/4 full at the outboard hole, by means of the filling needle. (See Figure 3-2).

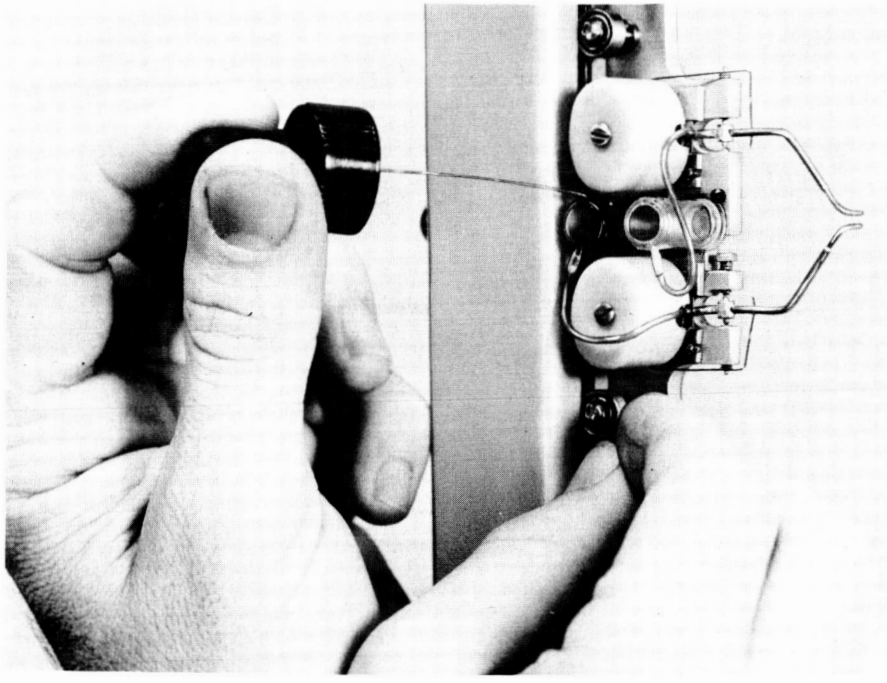


Figure 3-2. Refilling Ink Wells

c. Remove the pen from its jeweled bearings and allow it to hang vertically until gravity primes the hose and pen.

NOTE

The speed of priming is increased by the application of a blotter to the pen tip, and by squeezing the ink line. (See Figure 3-3).

d. Continue priming until the pen delivers a steady flow of ink and no air bubbles are visible in the hose.

e. Replace the pen in its bearings. (See Figure 3-4).

3-6. Replacing Bulbs

a. Slide the two rear access panels up; pivot them out

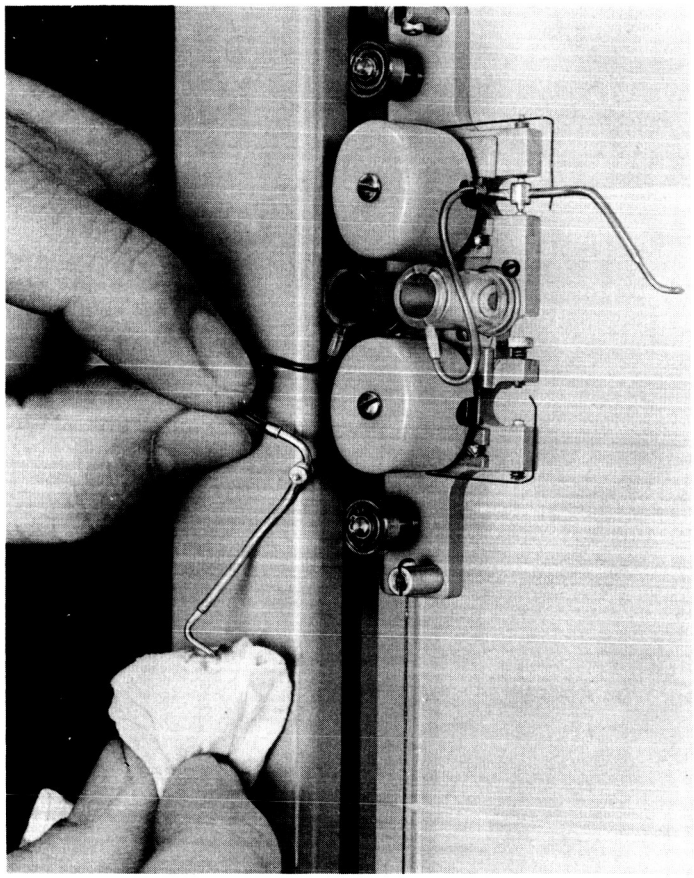


Figure 3-3. Priming the Pens

and lay them aside.

b. Turn the two pivot-type latches on each light pen access door.

c. Open the doors and replace the burned out bulbs. (See Figure 3-5.)

3-7. Adjusting Pen Vertical Spacing

The vertical space between the upper and lower pens on a particular arm can be adjusted by means of an adjusting screw. This space should be adjusted to 3/32" to 1/8". In order to equalize the vertical spacing of both sets of pens

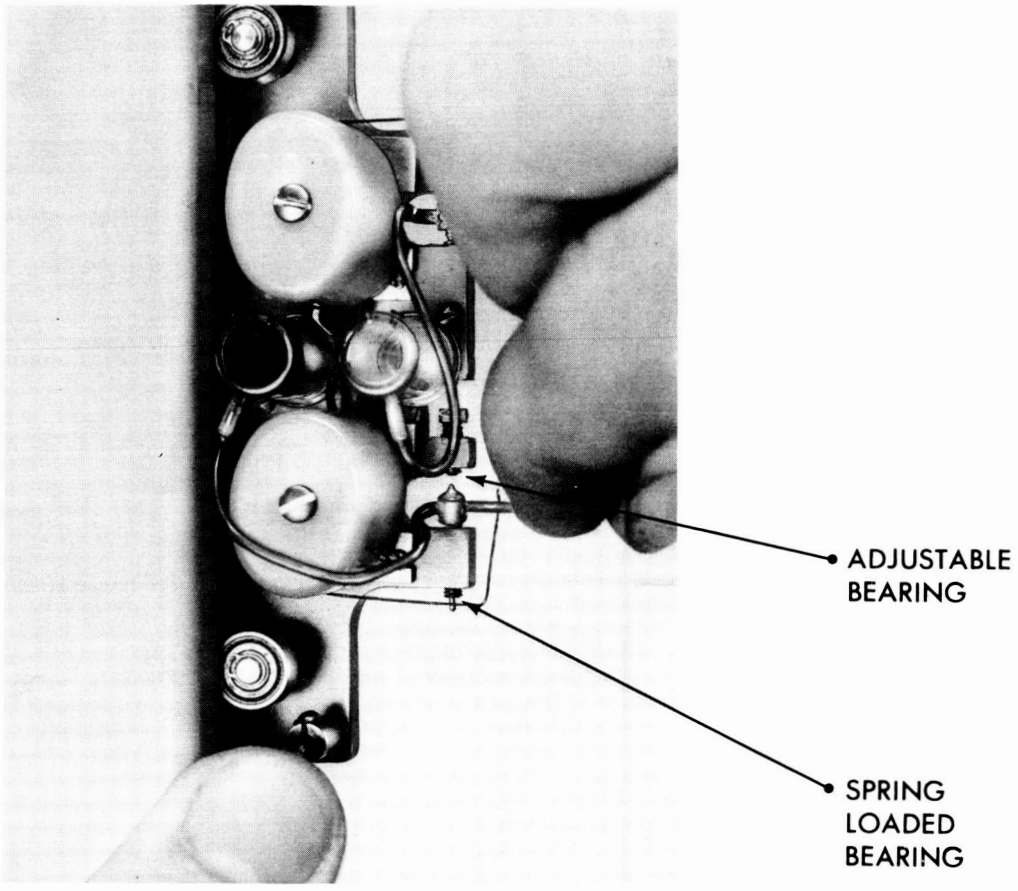


Figure 3-4. Replacing Pens

or to change the spacing proceed as follows:

a. Turn the adjustment on the required jeweled bearing to either raise or lower the required pen, as necessary.

NOTE

Normally, step (a) will fully accomplish the adjustment. However, under abnormal conditions it is possible that excessive adjustment of the movable pen bearing would cause improper spring pressure to be exerted by the spring loaded bearing. If the adjustable bearing must be varied

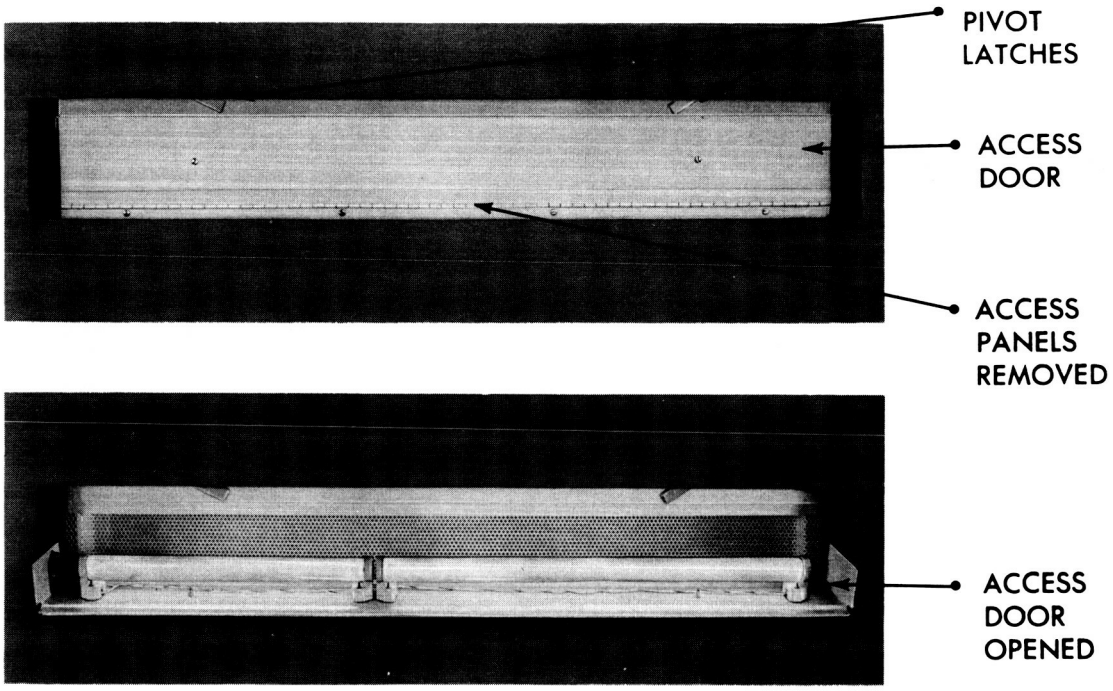


Figure 3-5. Back Lighting Access.

to move the pen more than 1/32 of an inch, such may be the case. If so, compensate for the changed load on the spring loaded bearing by adjusting the spring loaded bearing adjustment screw. Proper spring tension is present when there is just enough clearance for the pivot point when the pen is depressed against the spring loaded bearing and swung into place. (See Figure 3-4).

3-8. Adjusting the Pen Carriage on its Track

Adjust bearing pressure on the track as follows:

a. Loosen the eccentric shaft clamp screw. (See Figure 3-6).

b. Turn the eccentric bearing shaft as required to remove any slop.

NOTE

Manually run the carriage from top to bottom of the track to ascertain correct setting. There should be no apparent binding.

c. Tighten the clamp screw.

3-9. Adjusting Plotting Surface Flatness

The plotting surface has been carefully adjusted for flatness at the factory and normally should require no further field adjustment. However, it is possible for extreme ambient temperature fluctuations, or other environmental changes, to cause the plotting surface to become concave or convex (dished

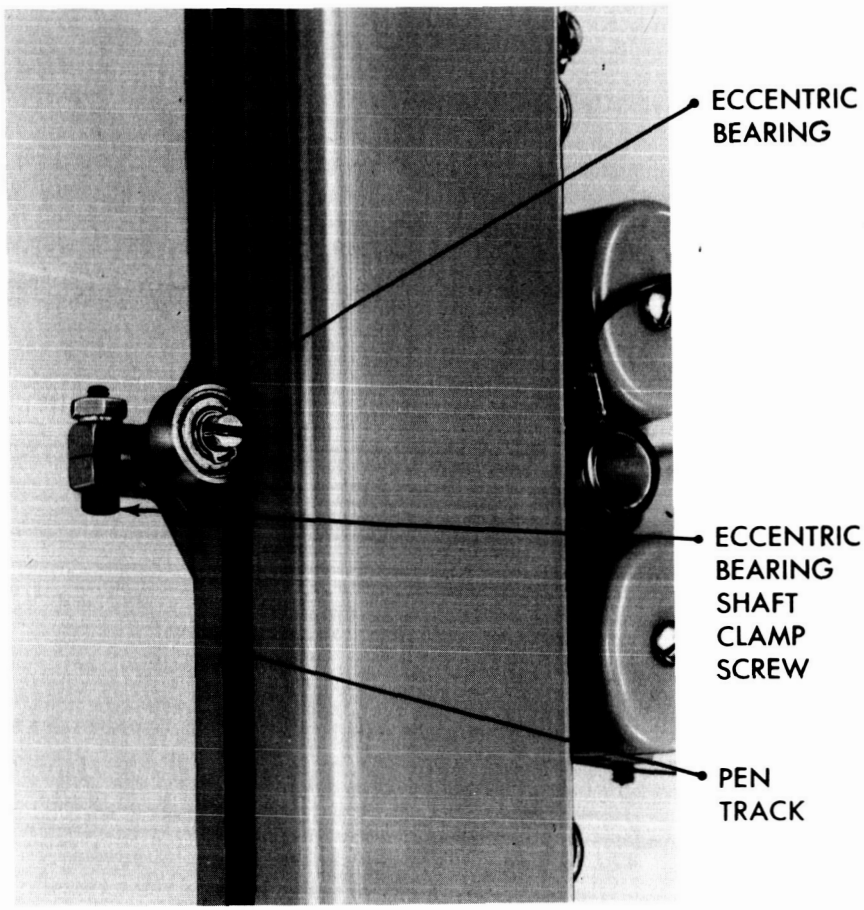


Figure 3-6. Pen Carriage Adjustment.

or bowed). Such warpage can be compensated for as follows:

a. Turn on board lights; adjust them to the intensity normally used and wait approximately one hour before proceeding.

NOTE

Two people are required for steps b and c.

b. Hold a true straight edge along the plotting surface.

c. Adjust the adjusting nut, accessible through the large access hole in the center of the back of the board,

until the board is flat as indicated by the straight edge. (See Figure 3-7).

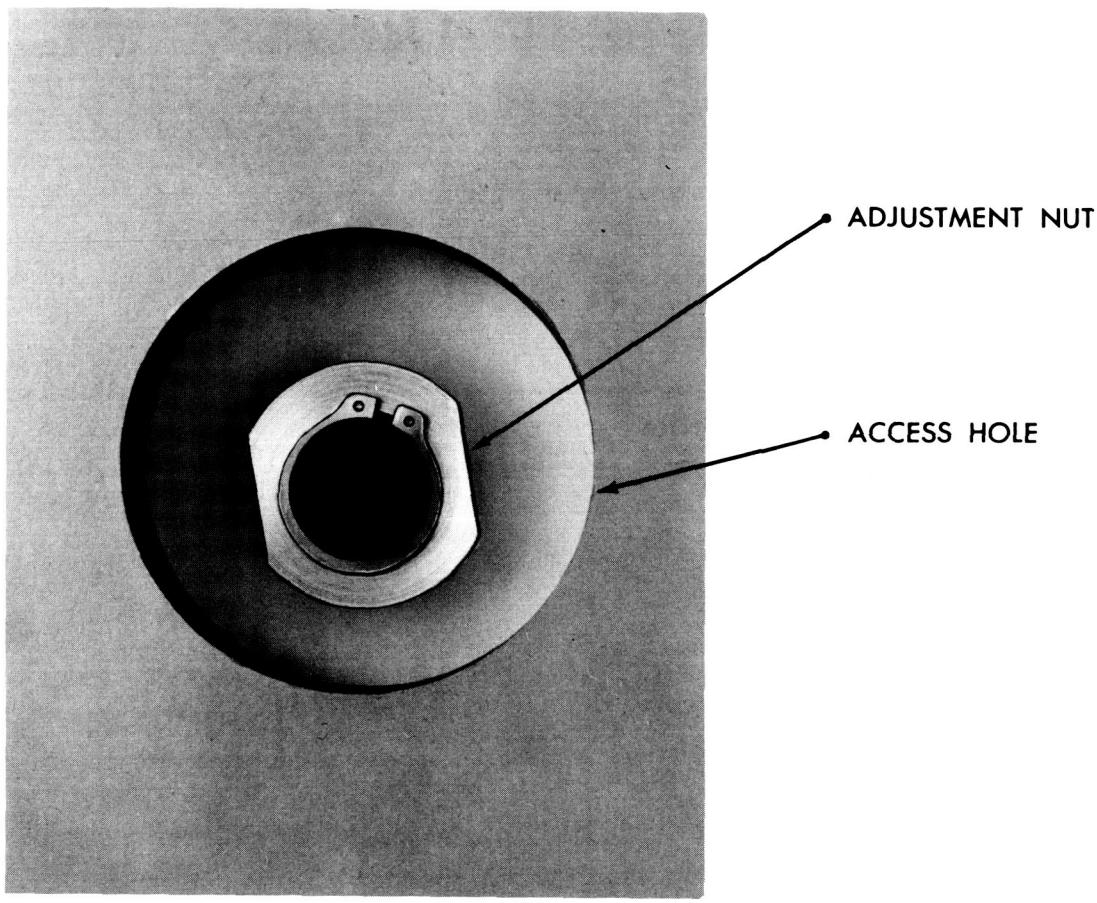


Figure 3-7. Plotting Surface Flatness Adjustment Nut.

3-10. Adjusting the Magnetic-Pneumatic Stops

The magnetic-pneumatic stop mechanism consists of a pneumatic cylinder and piston mounted on the left arm with an extended permanent magnet. A mechanical device for actuating or not actuating the pneumatic cylinder, depending on the velocity with which the arms converge on each other, is located on the right arm. This mechanism contains a steel pin whose vertical

travel is restricted. When it is down and the arms are converging, the piston rod of the left arm will contact the pin and actuate the pneumatic stop. When the pin is up and the arms are converging, the piston rod freely passes beneath it and there is no action of the pneumatic stop mechanism. Whether or not the pin is up or down depends on the speed with which the arms converge. If this magnet passes over the pin with a sufficiently high velocity, there is not sufficient time for the pin to be attracted to the magnet. In this case the pin will be contacted by the piston rod and the pneumatic stops will dampen the impact of the arms. At lower speeds the pin will be attracted by the magnet as it passes and the pneumatic stop mechanism will not actuate, allowing the arms to converge unrestircted. (See Figures 3-8 and 3-9). Adjust the mechanism as follows:

a. Adjust the magnet vertically so that when the pin is up there is approximately 0.005 inch clearance between the head of the pin and the magnet.

b. Loosen the lock nut and turn as required to move the magnet in or out (horizontally) in 1/32 inch increments. Each full turn is a 1/32 inch increment.

c. After horizontal and vertical adjustment, tighten the lock nut.

3-11. Adjusting the Drive Drum Circumference

NOTE

During calibration it may be necessary to vary

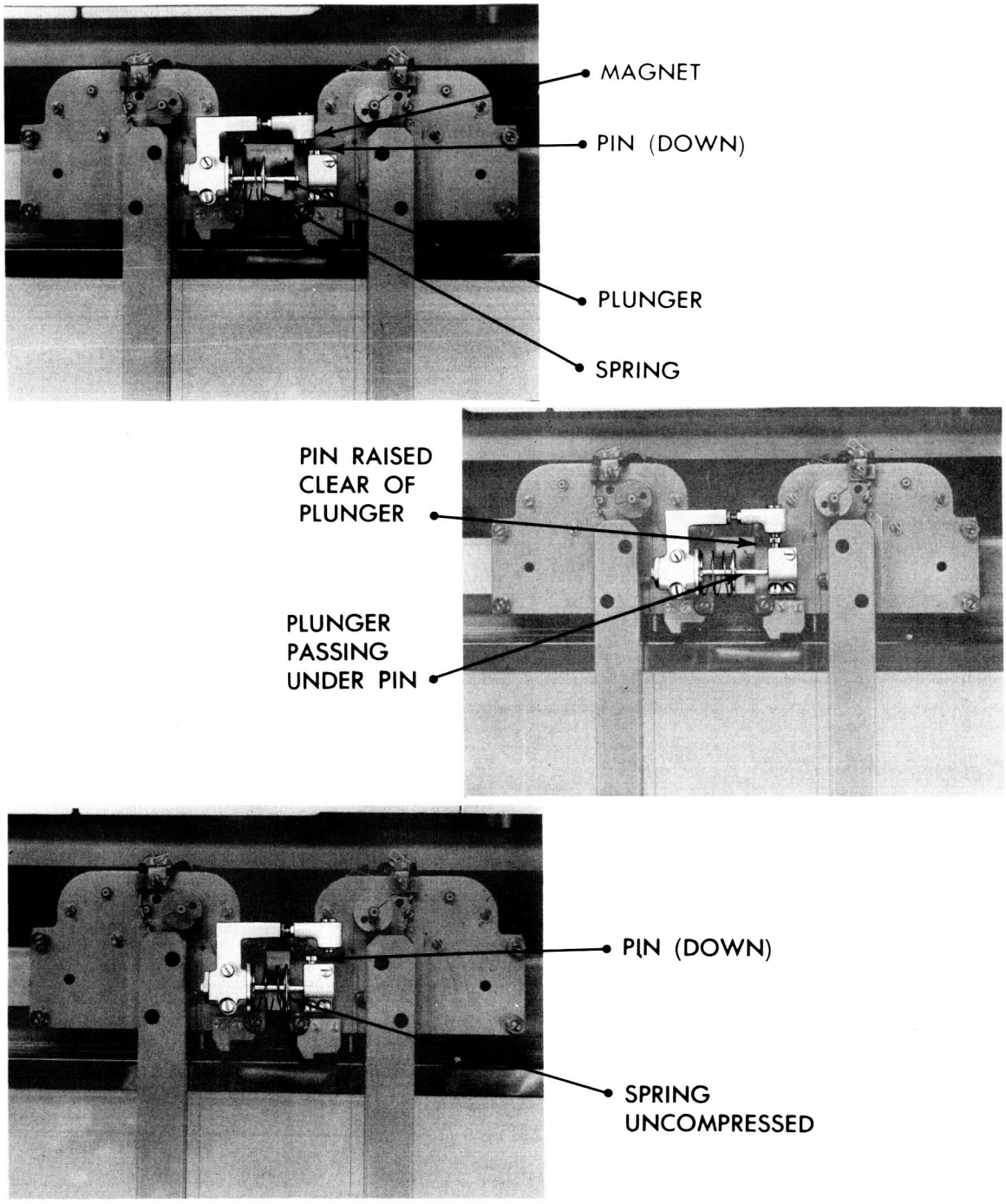


Figure 3-8. Magnetic-Pneumatic Stop; Low Speed Operation.

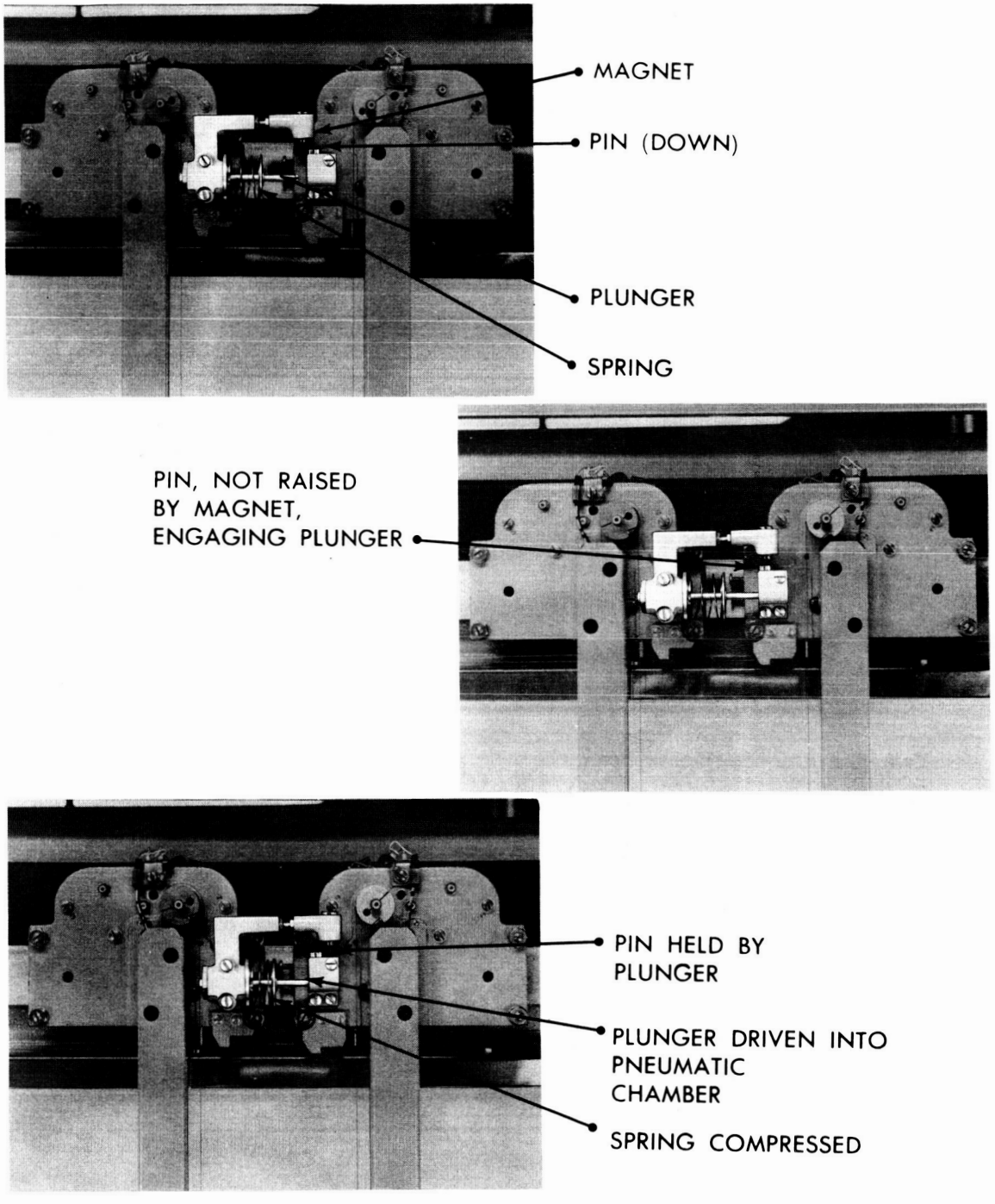


Figure 3-9. Magnetic-Pneumatic Stop; High Speed Operation

the travel of the arm (for a given number of drive drum revolutions) by expanding or contracting the drum. The arm will travel 3" for every revolution of the drum.

a. To expand the drum (increase arm travel) turn the adjustment screw in the end of the drive drum shaft clockwise. This pushes two tapered keys into the drum, expanding it slightly. (See Figure 3-10).

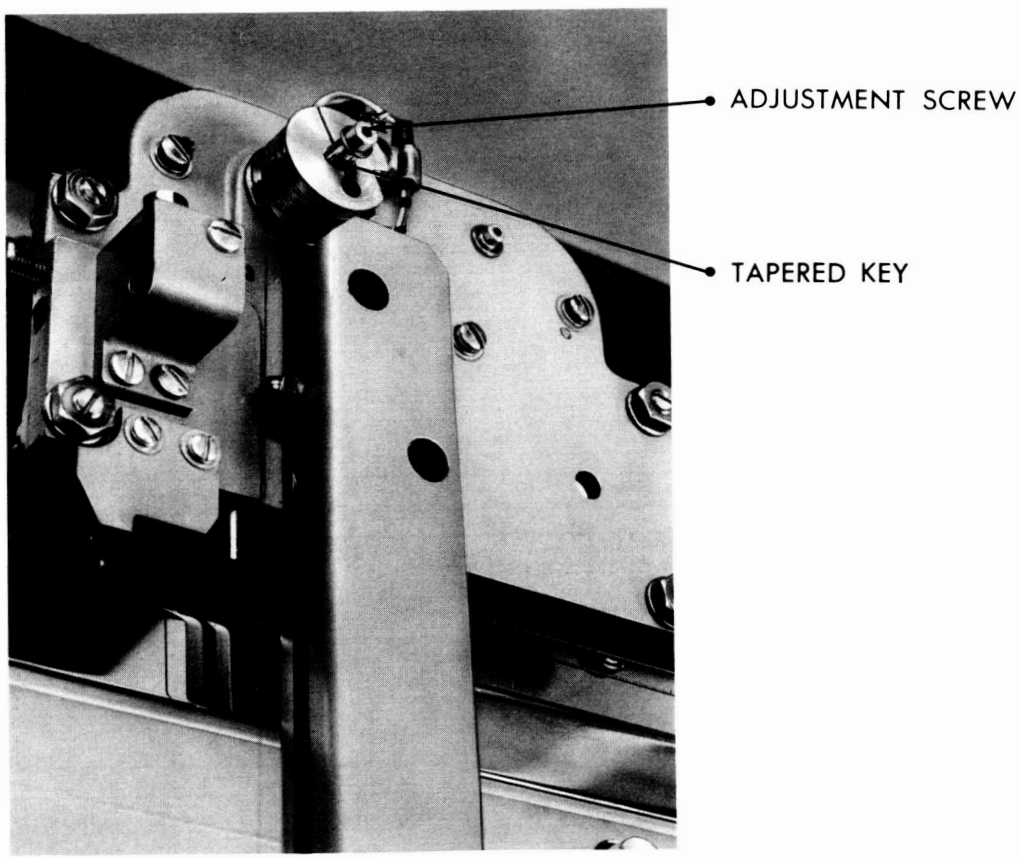


Figure 3-10. Drive Drum Circumference Adjustment

b. In order to decrease the circumference of the drum it is necessary to disassemble it by retracting the tapered keys, starting the adjustment from the smallest possible diameter.

NOTE

The adjusting screw should be turned in increments of one turn only, moving the pen carriage (or arm), from one extremity to the other between adjustments.

CAUTION

Never turn the drum circumference adjusting screw against cable tension; i.e., do not use cable tension to lock drum in place. When adjusting circumference, insert a screwdriver into the drum slot, to lock the drum and then turn the adjusting screw.

SECTION IV
OPERATION

4-1. General

The following procedure is designed to place the Recorder in condition to record input functions. Detailed procedures to be followed will depend largely on the nature of the functions to be plotted and specific requirements regarding parallax, scale factor, pen control functions, etc. A reading of the subsection on controls and their functions will facilitate adapting operation procedures to individual requirements.

a. Insure that power switches are off, vacuum pump is off, arms are in STANDBY mode, the INTERCHANGE switch is in the NORMAL position, and that the pens are raised, before connecting the unit to power.

b. Turn on the FILAMENT switch and allow approximately three minutes filament warm-up time.

c. Turn on the PLATE switch.

d. Energize the vacuum pump and place the tracing paper against the plotting surface. Smooth all wrinkles.

e. Place the required ARM switch in the OPERATE position. The recorder is now ready to plot.

4-2. Functions of Controls (See Figures 4-1 and 4-2)

The following tabulation lists the controls and corresponding functions relating to the sloping control area located immediately beneath the plotting surface.

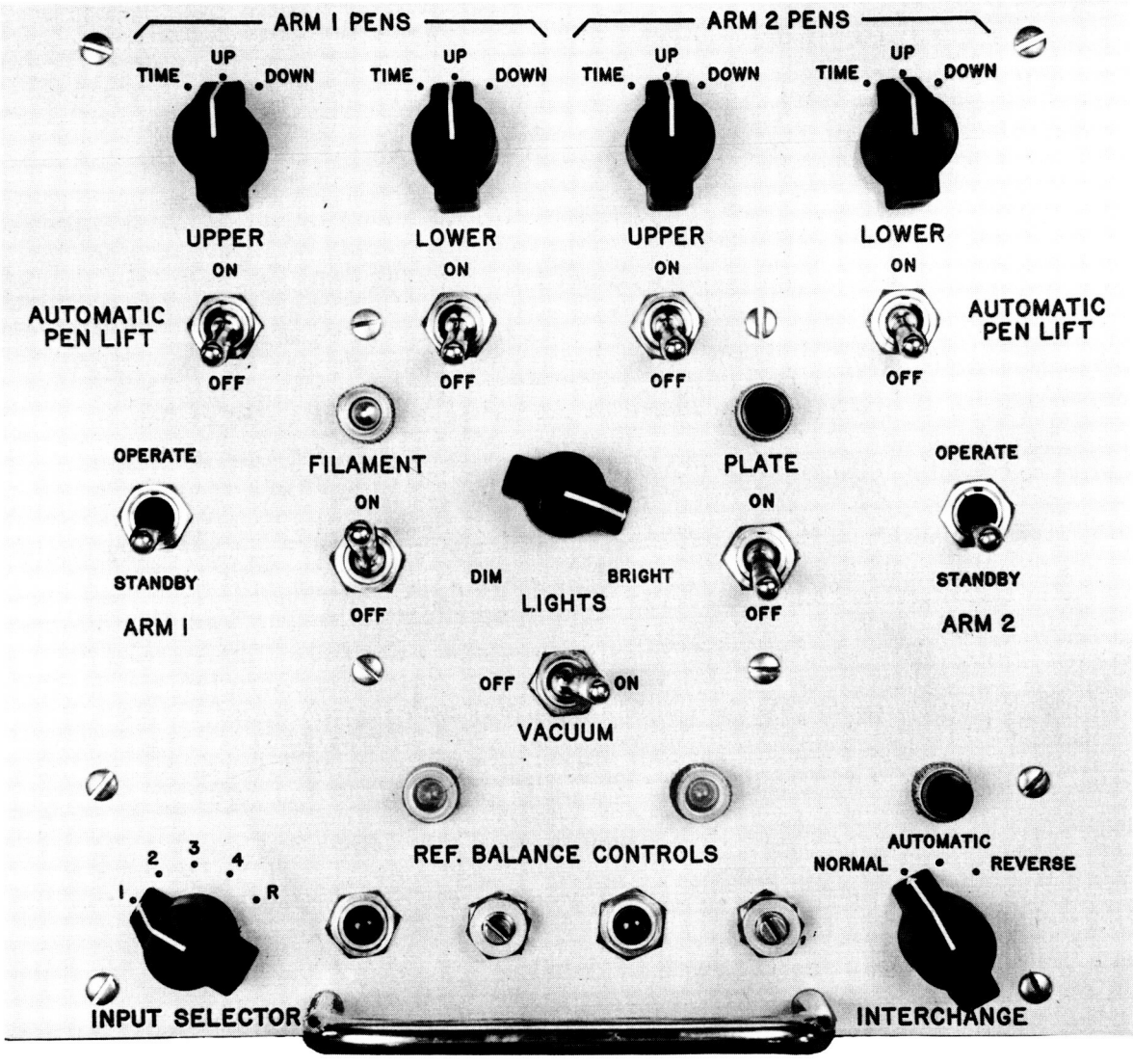


Figure 4-1. Control Chassis Panel.

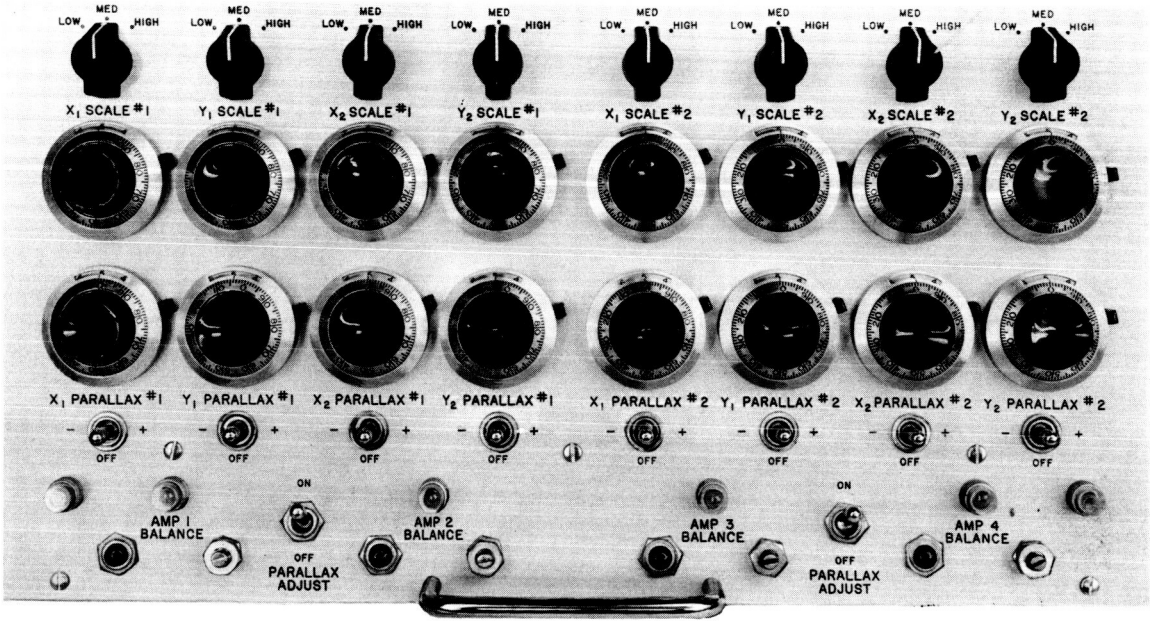


Figure 4-2. Typical Scale Factor and Parallax Chassis

Control	Function
ARM 1 and ARM 2	These two-position toggle switches enable selection of either the STANDBY or OPERATE mode for their associated arms. The pen plots the input function when the associated switch is in the OPERATE position. It moves to the side of the board and center of the arm when the switch is in the STANDBY position.
ARM 1 PENS ARM 2 PENS	The two pairs of three-position selector switches at the top of the panel control the four writing pens. Each switch of each pair controls either the upper or lower pen of its associated arm. The TIME position for a particular switch causes the corresponding pen to trace a series of timing marks which parallel the plot. These timing marks serve as a time-base indication for the plot. The UP and DOWN positions of the switches effect raising and lowering of the pens.
AUTOMATIC PEN LIFT	These four two-position toggle switches provide for automatic raising of any pen when slewing speed exceeds a preset amount.

INPUT SELECTOR — This selector switch selects any of the Scale Factor and Parallax Chassis as input source. The R position selects a remote source for controlling the choice of Scale Factor and Parallax Chassis.

VACUUM — This toggle switch energizes the vacuum pump which produces the vacuum which holds the tracing paper in place.

LIGHTS — This rheostat controls plotting surface back lighting intensity.

FILAMENT — This switch applies filament power; the presence of which is indicated by the amber light above the switch.

PLATE — This switch applies plate power; the presence of which is indicated by the red light above the switch.

INTERCHANGE — The three positions of the selector correspond to the three pen interchange modes of operation. When the switch is in the NORMAL position, X_1 and Y_1 inputs are applied to the left arm and pen, and X_2 and Y_2 inputs are applied to the right arm and pen.

These inputs are switched to the opposite arms and pens of the plotting surface when the switch is in the REVERSE position. The AUTOMATIC position provides for the automatic interchange of these functions when the arms approach the point at which they would theoretically have to pass through each other in order to continue their respective plots. When the switch is in the AUTOMATIC position and the arms do reach this critical position, they interchange their functions and recede from each other; each now plotting the other's function. The interchanged mode is indicated by the red lamp.

X_1 SCALE

This section of the panel controls the multiplication factor of the input signal and hence expands or contracts the plot. The three general ranges, labeled LO, MED and HIGH are selected by the three-position switch. In the LOW position only a second section of the switch shorts out the 13 K resistor (R202). The

knob adjustment below the switch serves as a vernier within the three basic ranges.

X_1 PARALLAX

This section controls the location of the plot origin. The toggle switch selects either a + or - reference voltage as input to the d. c. amplifiers. This voltage is generated by the reference amplifiers. The + and - voltages correspond to the right and left sides of the board, respectively. The magnitude of these inputs is adjusted by the potentiometer knob control above the switch.

NOTE

The Y_1 and Y_2 controls are similar except that + and - reference voltages here correspond to the upper and lower portions of the board, respectively. The X_2 and Y_2 sections of the panel function as do the X_1 and Y_1 sections, except that the right arm and pen are affected.

SECTION V
MAINTENANCE

5-1. Cleaning the Tracks and Grooves

The arm tracks and pen carriage grooves should be kept completely free of dust and other foreign matter at all times. They should be inspected regularly, and periodically wiped with a clean, dry, lint-free cloth and oiled lightly with light machine oil.

CAUTION

Never oil any part of the vacuum pump or system. This is an oiless system.

5-2. Removal of Ink Well, Hose and Pen Assembly

a. Loosen the two screws which attach the well to be removed. (See Figure 5-1).

NOTE

It is not necessary to remove the attaching screws. Merely loosen them until their heads protrude approximately 1/16 to 3/32 of an inch above the mounting flange; enough to detach the flange.

b. Gently press the pen to be removed against the spring loaded pen pivot jewel bearing.

NOTE

The spring loaded jewel bearing for the upper pen is the upper bearing. The

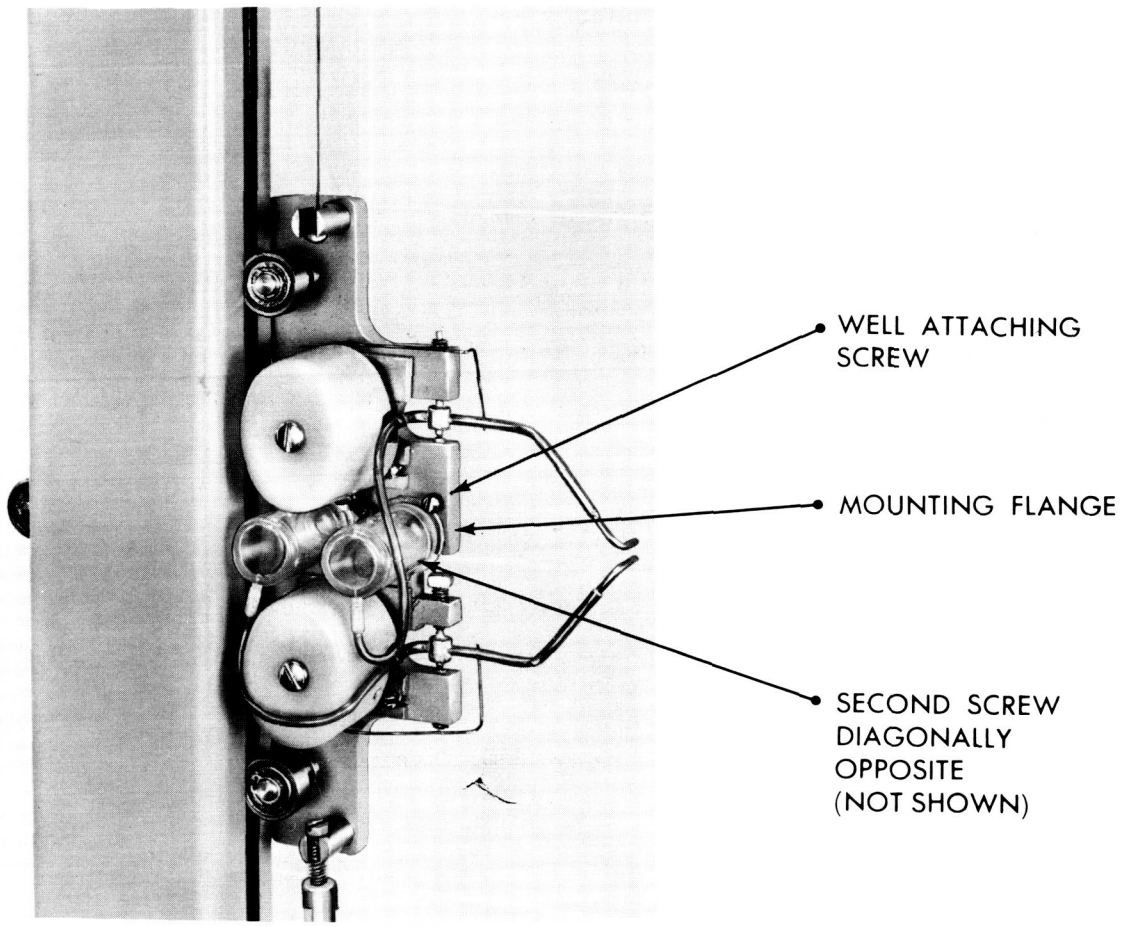


Figure 5-1. Ink Well, Hose, and Pen Assembly Removal.

spring loaded jewel bearing for the lower pen is the lower bearing.

c. Pivot the pen assembly away from its mounting and remove the entire ink well, pen and hose assembly.

d. Reassembly is the reverse of steps a through c.

5-3. Arm Feedback Potentiometer Removal and Replacement

The arm drive gear boxes are located at the upper right and left corners of the board. Each contains two servo motors and

one potentiometer. The potentiometer is the servo feedback voltage source and is mounted on a "stand-off" to facilitate field replacement. The potentiometer can be removed according to the following procedure:

a. Disconnect all wiring to the potentiometer.

b. Insert a suitable Allen wrench through the access hole in the "stand-off" and loosen the Allen screw. (See Figure 5-2).

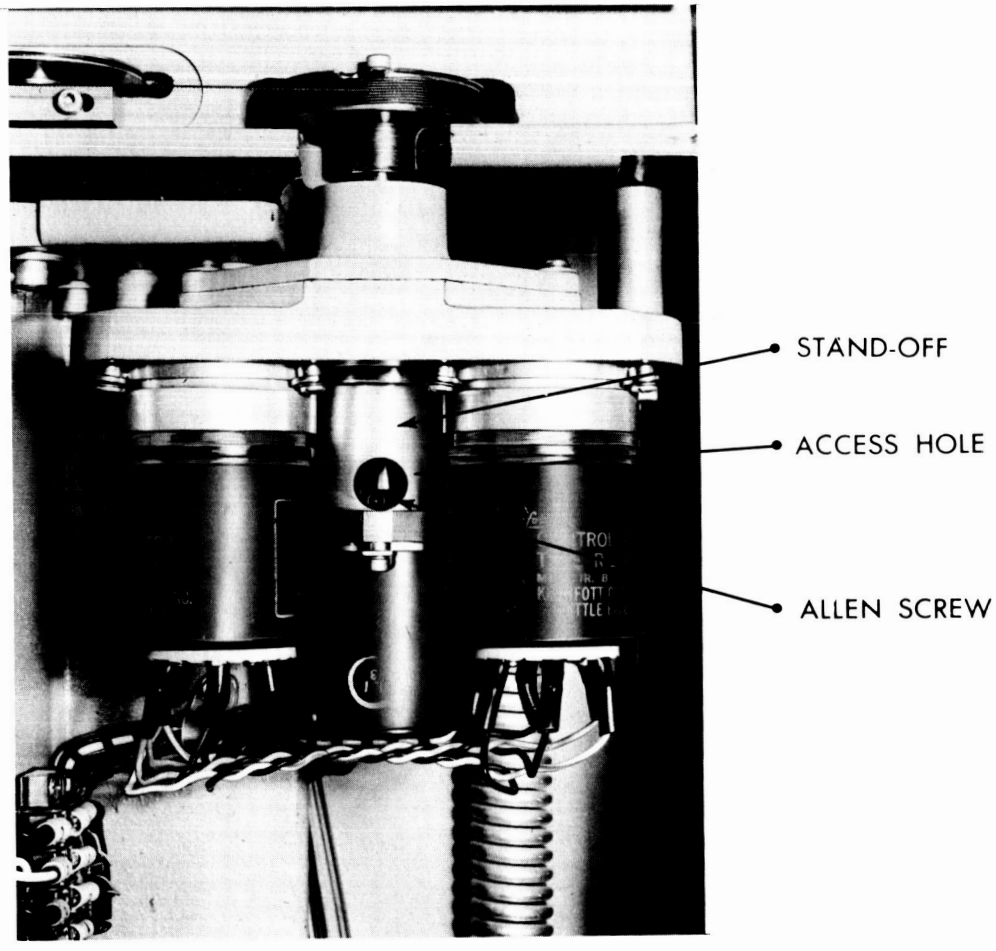


Figure 5-2. Arm Feedback Potentiometer Decoupling.

NOTE

It may be necessary to position the arm either to the right or left and hold it in such a position that the Allen screw is moved to an accessible position, in line with the access hole.

c. Loosen the three screws attaching the potentiometer to the "stand-off." (See Figure 5-3).

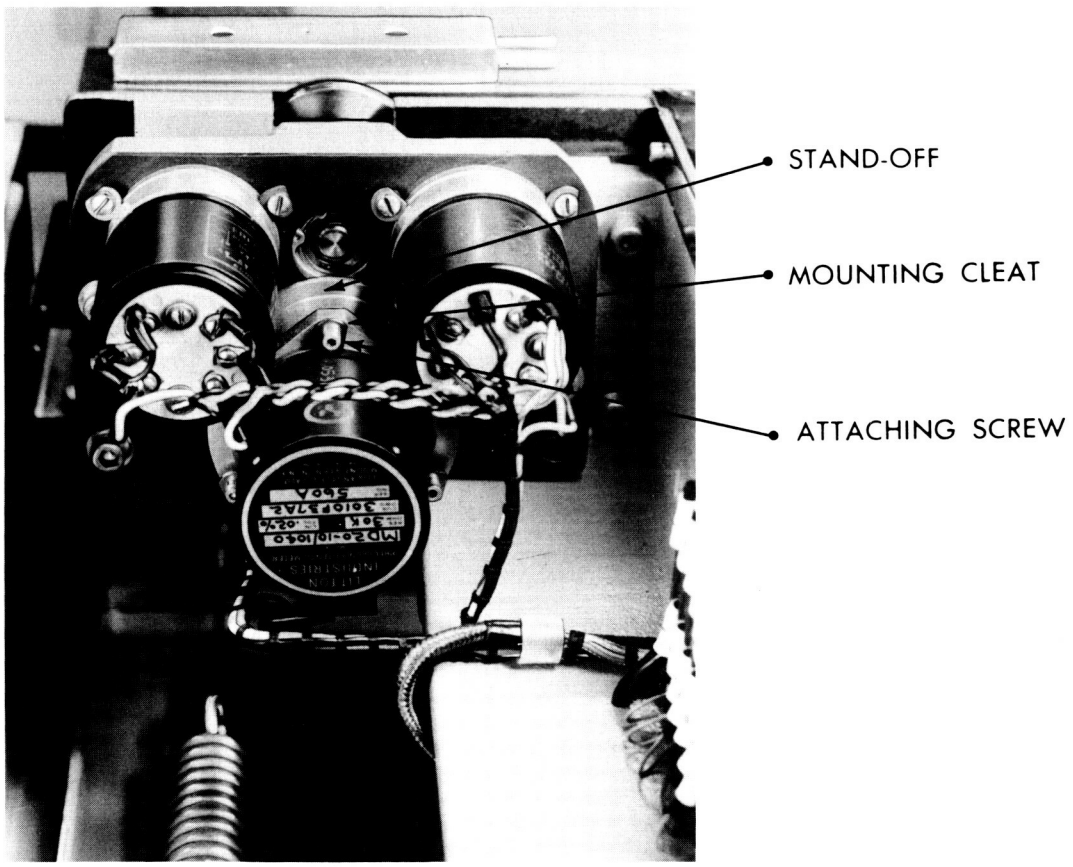


Figure 5-3. Arm Feedback Potentiometer Removal.

d. Hold the potentiometer and rotate the three cleats so that their flats allow the base of the potentiometer sufficient clearance for removing it.

e. Remove the potentiometer. Replace the potentiometer essentially by reversing the preceding removal procedure. However, observe the following points while doing so:

(1) Position the potentiometer shaft in as central a position as possible (approximately 5 turns from either stop), before replacing.

(2) Place the arm in as central a position as possible.

NOTE

Steps (1) and (2) insure that the central positions of the arm and potentiometer shaft approximately coincide.

5-4. Pen Feedback Potentiometer Removal and Replacement

This procedure parallels that of paragraph 5-3, Arm Feedback Potentiometer Removal and Replacement, except that centering is along the vertical axis of the plotting surface.

5-5. Replacing Arm Drive Cables

The following procedure applies to the left arm. Follow a similar procedure when replacing the right arm drive cables.

The arm is moved by two cables. One short cable is passed from the arm to the drive drum. (See Figure 5-4). One long cable

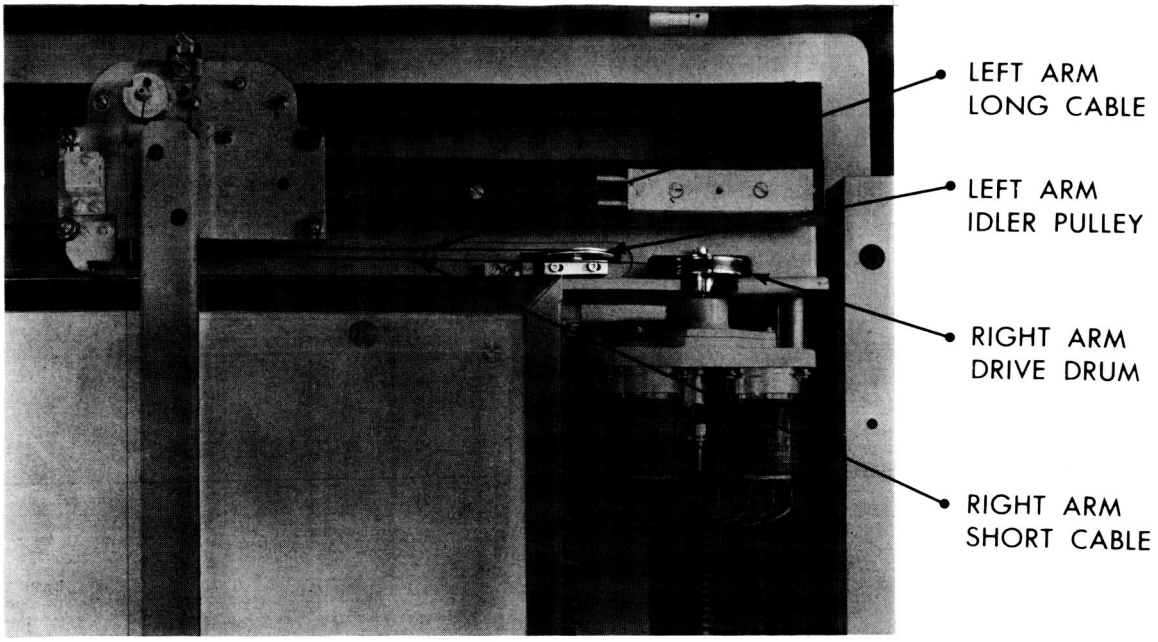


Figure 5-4. Right Arm Cable (Short).

is passed from the arm, over the idler pulley; passed in back of the horizontal cross member, through the cored hole in the member, and to the drive drum. (See Figure 5-5). Replace the cables according to the following procedure:

NOTE

Two people are required for the procedure.

a. Loosen the idler pulley adjustment set screw, located on the left side of the mounting block, to move the mounting block to the extreme left position. (See Figure 5-6).

b. Rotate the L.H. arm drive gear box drive drum in a counter clockwise direction until it hits the internal stop on the pot.

c. Move the left arm to the extreme right side of the board.

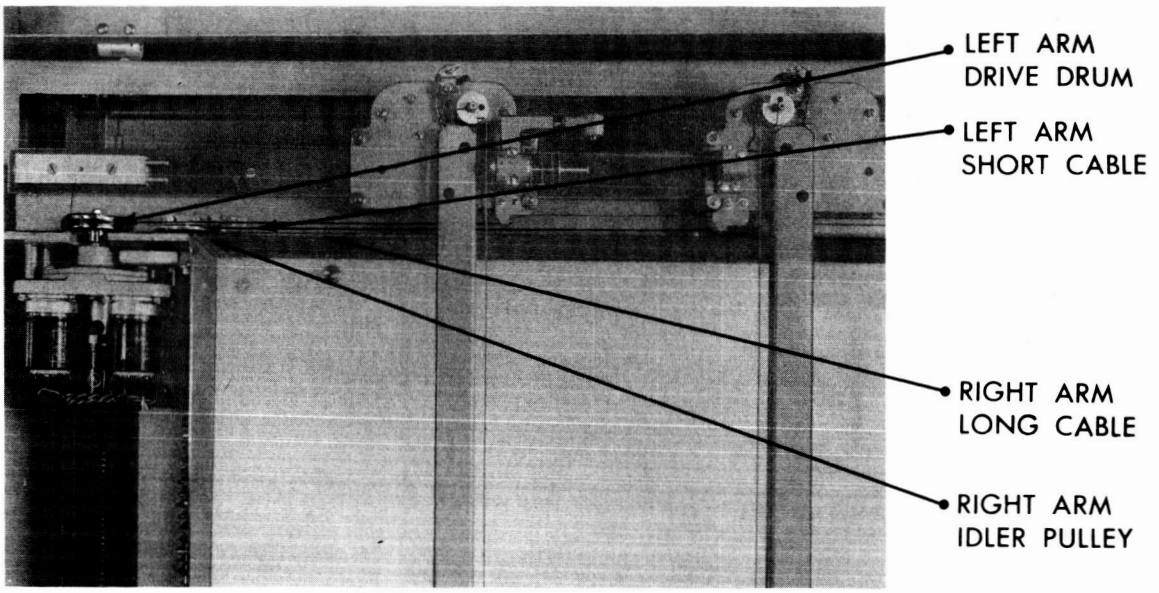


Figure 5-5. Right Arm Cable (Long).

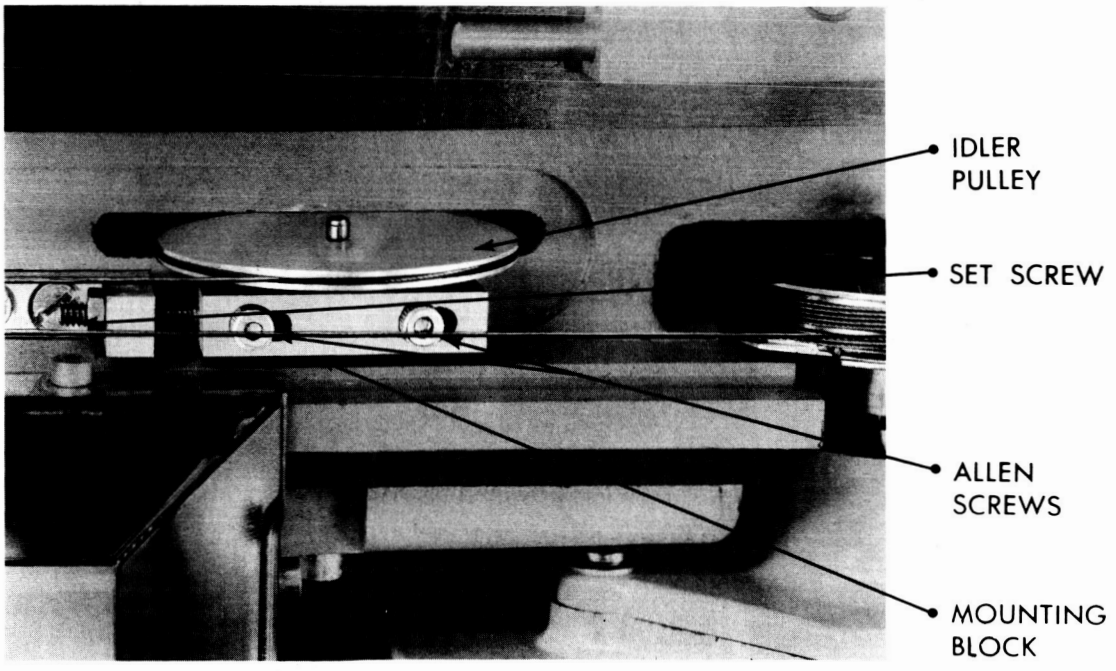


Figure 5-6. Idler Pulley Adjustment.

d. Insert one end of the short cable in the lower termination slot on the drive drum and make a sufficient number of "idle" turns (approximately 1 1/2) so that the other end is the correct length to insert in the termination block on the arm supporting casting.

e. Wind the cable onto the drum, maintaing cable tension, until the arm has been repositioned to the extreme left side of the board.

CAUTION

The winding operation is critical. Insure that adjacent windings never overlap and that there are no spaces between windings.

f. Hold the drive drum to maintain cable tension sufficient to cause the arm to rest against the outer spring stop.

g. Insert one end of the long cable in the upper termination slot on the drive drum and make approximately 1 1/2 "idle" turns. Thread the free end through the cored hole, down the back of the cross member, up through the cored hole and over the idler pulley on the opposite end.

h. If the proper number of turns have been made on the drive drum, there will now, just sufficient slack to enable you to attach the opposite end of the cable to the termination block on the arm support casting.

i. Keep the cable under tension and readjust the idler pulley to the right, by means of the set screw, until the remaining slack is eliminated.

j. Tighten the idler pulley mounting block securely in place with the two Allen screws.

5-6. Replacing the Pen Carriage Drive Cables

This procedure applies to the left pen carriage drive cables. Follow a similar procedure when replacing the right pen carriage drive cables. It is necessary to remove the arm before removing the pen carriage drive cables.

Disconnect the cable from the terminal board on the side of the casting, and remove the upper and lower outboard spring stops and slide the arm off the end of the track. Place it on a suitable work bench. The execute the following procedure:

NOTE

Two people are required for the remainder of the procedure.

a. Tape one end of the longer cable to one end of a wire or rod approximately 1/16 or 3/32 of an inch in diameter and 40 inches long and carefully thrust the rod through the center of the arm.

CAUTION

Do not twist or in any way interfere with other wires inside the arm.

b. Detach the cable from the rod and extract the rod.

c. Place the pen carriage at the extreme upper end of the arm.

d. Attach the upper end of the cable to the termination point on the drive drum. Make two "IDLE" turns in a counter

clockwise direction. Lead central section of cable over the idler pulley at the bottom of the arm, taking care to keep a fair amount of tension on the cable at all times.

e. Attach other end of cable to its termination point on the pen carriage.

f. Carefully turn the drum in a clockwise direction while maintaining cable tension. Continue to take up cable on the drum until the pen carriage is positioned against the lower spring stop on the arm.

CAUTION

The winding operation is critical. Insure that adjacent windings never overlap and that there are no spaces between windings.

g. Continue taking up cable and depress the carriage against the spring stop.

h. Insert a plastic or other non-metallic wedge through the hole in the upper casting so that it locks the drive gears, thus maintaining cable tension. (See Figure 5-7).

i. Attach eyelet end of short cable to the other termination point on the drive drum.

j. Make two "idle" turns in a clockwise direction.

k. Attach turnbuckle end of cable to pen carriage.

i. Take up slight remaining slack by tightening the turnbuckle Remove the turnbuckle from the pen carriage

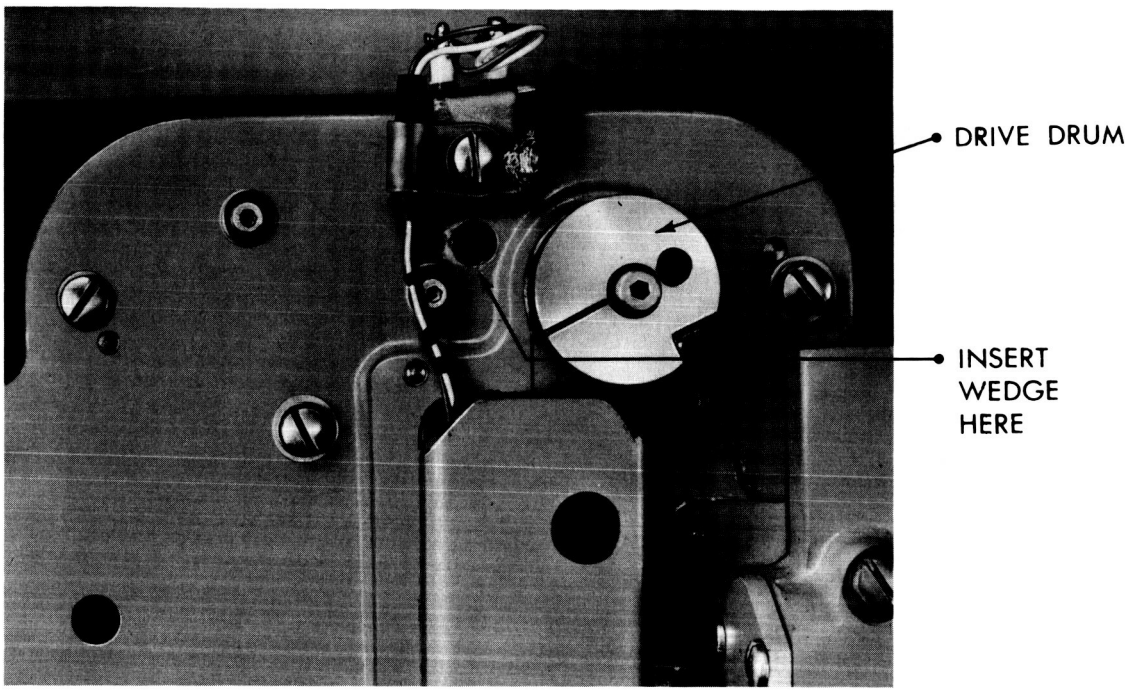


Figure 5-7. Locking Pen Carriage Drive Drum.

and turn the screw in.

m. Release pressure on the plastic wedge by depressing pen carriage against the spring stop, and remove the wedge.

5-7. Replacing the Contact Cable Assembly

The arm assembly must be removed from the plotting board and the upper and lower castings removed from the arm extrusion, prior to performing this procedure. When this has been accomplished, proceed as follows:

a. Lay the detached arm extrusion on a work bench and pass the contact cable through the center of the extrusion according to the procedure outlined in

steps b and c of paragraph 5-6, Replacing the Pen Carriage Drive Cables.

b. Pass each free end of the cable over its appropriate idler pulley at either end of the extrusion and attach each nylon "half-moon" to its associated termination point on the upper and lower ends of the pen carriage. (See Figure 5-8).

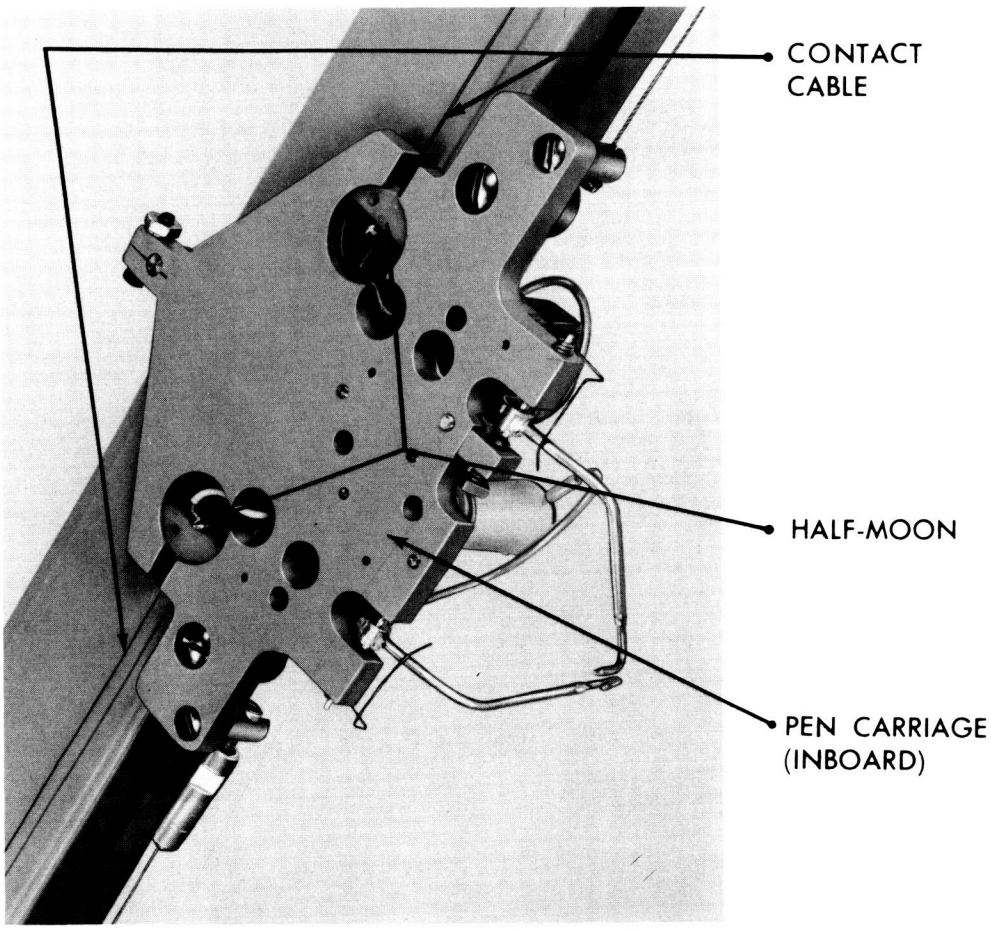


Figure 5-8 Contact Cable Installation
(Rear Surface)

NOTE

The center springs of this assembly produce tension sufficient to hold both nylon "half-moons" in place.

c. Reassemble castings to the arm extrusion.

d. Rewind the drive cables.

e. Place the arm assembly back on the track.

f. Square the arms according to paragraph 5-8 Squaring the Arms.

5-8. Squaring the Arms

NOTE

This adjustment has been made at the factory and normally should not be necessary unless the equipment has been subjected to improper handling or unless the arms have been removed.

a. Loosen the lock nuts locking the lower bearing eccentric shafts. (See Figure 5-9).

b. Turn both lower bearing eccentric shafts so that both lower bearings fall clear of the track.

c. Loosen the lock nut locking the upper bearing eccentric shaft.

d. Turn the eccentric shaft of the upper bearing to rotate the arm until it is exactly vertical, with respect to the plotting surface.

NOTE

Construct a vertical reference line by

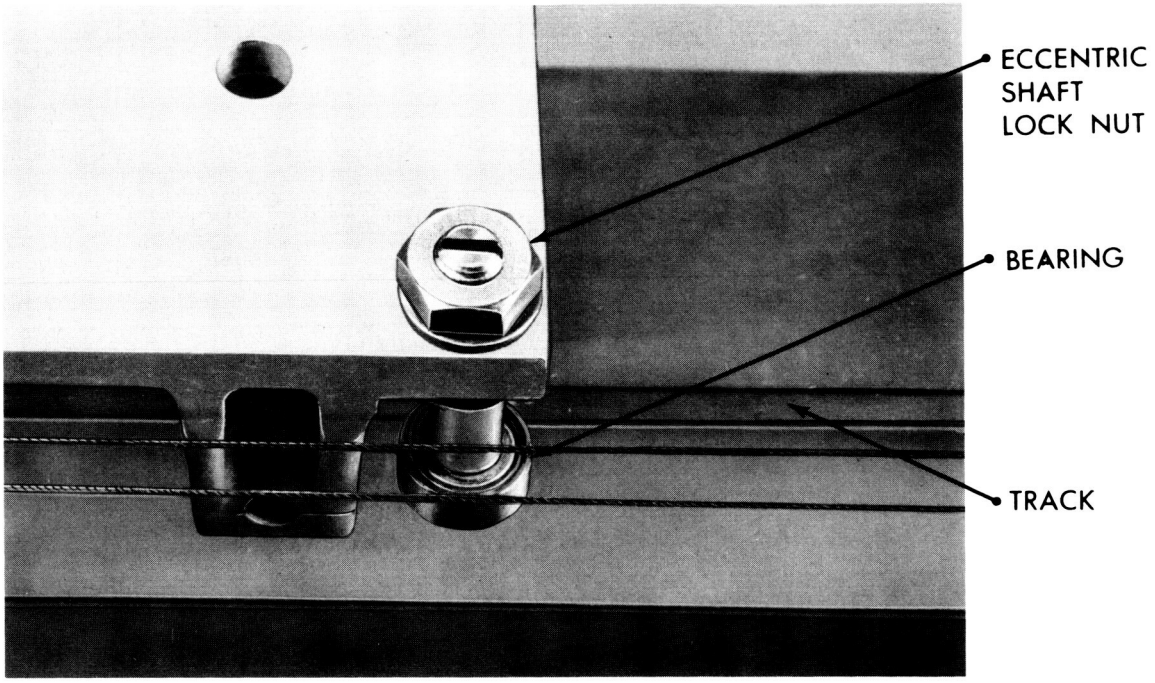


Figure 5-9. Lower Bearing Adjustment.

drawing a horizontal line with the pen
and constructing a perpendicular bisector
to it.

e. Tighten the upper bearing eccentric shaft lock nut.

f. Turn both lower bearing eccentric shafts until the lower bearings lightly contact the arm track.

g. Tighten the lower bearing eccentric shaft lock nuts.

SECTION VI
PARTS LIST

MEC MODEL 3010 X-Y RECORDER

Modified per

IBM SPEC. #3218307

1	2	3		4	5	6	7
ITEM NO.	REFER. DESIG-NATOR	CLASS	STOCK NO.	MFG. AND PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNIT PER ASSY.	PROCURE-MENT CODE
86-1				MEC Model 3010	RECORDER, X-Y		
86-2				MEC E3032-86B	CHASSIS, Scale Factor and Parallax	1	
86-3	C1, C9, C101, C109			Cornell Dubilier BYA10D22	CAPACITOR, Fixed, Ceramic, 2200$\mu\mu$f 1000 vdc	4	
86-4	C2, C10 C102, C110			Cornell Dubilier PM4P1	CAPACITOR, Fixed, Molded Mylar, .1μf 400 vdc	4	
86-5	C3, C11, C103, C111			Aerovox Type SRE	CAPACITOR, Fixed, Electrolytic, Tubular, Molded Mylar, 50μf 6 vdc	4	
86-6	C4, C7, C12 C15-C18 C104, C107 C112, C115-C118			Cornell Dubilier PM4S1	CAPACITOR, Fixed, Molded Mylar, .01μf 400 vdc	14	
86-7	C5, C13 C105, C113			Arco DM15-330K	CAPACITOR, Fixed, Dur-Mica, 33$\mu\mu$f 500 vdc	4	
86-8	C6, C14 C106, C114			Aerovox AEP88D4A	CAPACITOR, Fixed, Electrolytic, Plug-In type triple 40-40-20 μf 150/25 vdc	4	
86-9	C8, C16 C108, C116			Aerovox JP616MCB	CAPACITOR, Fixed, Hermetically sealed, 1.0 μf (CP65B1EF105K)	4	
86-10	C19, C20 C119, C120			Arco DM15-220K	CAPACITOR, Fixed, Dur-Mica, 22$\mu\mu$f 500 vdcw	4	
86-11	CR1-CR4 CR101-CR104, CR201, CR301			General Elec. 1N1692	DIODE	10	

1	2	3		4	5	6	7	8
ITEM NO.	REFER. DESIG-NATOR	CLASS	STOCK NO.	MFG. AND PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNIT PER ASSY.	PROCURE-MENT CODE	UNIT COST (EST.)
86-12	CR5-CR8, CR105-CR108			Hughes HD6227	DIODE	8		7.32
86-13	DS1, DS2 DS101, DS102			Eldema 1CG12-4535	LAMP, Neon to Spec. 21C-3864-7	4		2.55
86-14	I1, I101			Eldema 1CF12-4589	LAMP, Incandescent (28V)	2		2.51
86-15	K1-K4			MEC A3032F86B	RELAY, Sealed, Type J, 6 Form A, Code 24, 28 V, approx. 300 Ω (modified from C.P. Clare RP4461-G29)	4		28.00
86-16	K51, K151			MEC	CONVERTER, (Chopper), DC to AC, 12V coil, 94 cps make before break contacts, 0-15 vdc 1ma	2		78.65
86-17	P1			MIL MS3102A28-15P (DAP)	CONNECTOR, Box mounting	1		4.51
86-18	P2			MIL MS3102A28-15PX (DAP)	CONNECTOR, Box mounting	1		4.65
86-19	R101, R129			MIL RC20GF125K	RESISTOR, Fixed composition, 1.2M ±10% 1/2W	2		.17
86-20	R2, R30, R102, R130			MIL RC20GF204J	RESISTOR, Fixed composition, 200K ±5% 1/2W	4		.34
86-21	R103, R131			MIL RC20GF754J	RESISTOR, Fixed composition, 750K ±5% 1/2W	2		.34
86-22	R4, R32 R104, R132			MIL RC20GF513J	RESISTOR, Fixed composition, 51K ±5% 1/2W	4		.34
86-23	R8, R36, R105, R108, R133, R136			MIL RC20GF274K	RESISTOR, Fixed composition, 270K ±10% 1/2W	6		.17

1	2	3		4	5	6	7	8
ITEM NO.	REFER. DESIG-NATOR	CLASS	STOCK NO.	MFG. AND PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNIT PER ASSY.	PROCURE-MENT CODE	UNIT COST (EST.)
86-25	R7, R35 R107, R135			Allen Bradley JLU 5041 or JA1L040S504UC	POTENTIOMETER, Variable, Composition, Linear Taper, 500K ±10% 2W	4		3.57
86-26	R9, R38 R109, R138			MIL RC20GF683K	RESISTOR, Fixed, Composition, 68K ±10% 1/2W	4		.17
86-27	R10, R37, R58 R59, R69, R70 R110, R137, R158, R159, R169, R170			MIL RC20GF473K	RESISTOR, Fixed composition, 47K ±10% 1/2W	12		.17
86-28	R11, R39, R111, R139			MIL RC20GF365J	RESISTOR, Fixed composition, 3.6M ±5% 1/2W	4		.34
86-29	R12, R40 R112, R140			MIL RC20GF824K	RESISTOR, Fixed composition, 820K ±10% 1/2W	4		.17
86-30	R13, R41, R113, R141			MIL RC32GF222K	RESISTOR, Fixed composition, 2.2K ±10% 1W	4		.25
86-31	R1, R14, R42 R29, R63, R65, R114, R142, R163, R165			MIL RC20GF105K	RESISTOR, Fixed composition, 1M ±10% 1/2W	10		.17
86-32	R15, R20, R43, R48, R115, R120, R143, R148			MIL RC20GF225K	RESISTOR, Fixed composition, 2.2M ±10% 1/2W	8		.17
86-33	R16, R22, R44, R50 R116, R122 R144, R150			MIL RC20GF272K	RESISTOR, Fixed composition, 2.7K ±10% 1/2W	8		.17

1	2	3		4	5	6	7
ITEM NO.	REFER. DESIG-NATOR	CLASS	STOCK NO.	MFG. AND PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNIT PER ASSY.	PROCURE-MENT CODE
86-34	R17, R21, R23, R45, R49, R51, R117, R121 R123, R145 R149, R151			MIL RC20GF334K	RESISTOR, Fixed composition, 330K ±10% 1/2W	12	
86-35	R18, R24, R46, R52 R118, R124 R146, R152			MIL RC20GF623J	RESISTOR, Fixed composition, 62K ±5% 1/2W	8	
86-36	R19, R25, R47, R53, R61, R62, R119, R125, R147, R153, R161, R162			MIL RC20GF154K	RESISTOR, Fixed composition, 150K ±10% 1/2W	12	
86-37	R26, R54, R126, R154			MIL RC20GF104K	RESISTOR, Fixed composition, 100K ±10% 1/2W	4	
86-38	R27, R55, R127, R155			MIL RC20GF474K	RESISTOR, Fixed composition, 470K ±10% 1/2W	4	
86-39	R28, R56, R128, R156			MIL RC20GF107K	RESISTOR, Fixed composition, 100M ±10% 1/2W	4	
86-40	R57, R60, R68, R71, R157, R160 R168, R170			MIL RC20GF333K	RESISTOR, Fixed composition, 33K ±10% 1/2W	8	
86-41	R64, R66 R164, R166			MIL RC20GF103K	RESISTOR, Fixed composition, 10K ±10% 1/2W	4	
86-42	R67, R167			Sprague Type 151E	RESISTOR, Fixed, 12Ω ±10% 3W	2	

1	2	3		4	5	6	7
ITEM NO.	REFER. DESIG-NATOR	CLASS	STOCK NO.	MFG. AND PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNIT PER ASSY.	PROCURE-MENT CODE
86-43	R202, R209 R216, R223 R302, R309 R316, R323			MEC	RESISTOR, Precision per MEC Dwg. A1007F6A1 13K ±.1%	8	
86-44	R204, R211 R218, R225, R304, R311 R318, R325			MEC	RESISTOR, Precision per MEC Dwg. A1007F6A1 2 megohm ±.1%	8	
86-45	R205, R212 R219, R226 R305, R312 R319, R326			MEC	RESISTOR, Precision per MEC Dwg. A1007F6A1 500K ±.1%	8	
86-46	R206, R213 R220, R227 R306, R313 R320, R327			MEC	RESISTOR, Precision per MEC Dwg. A1007F6A1 125K ±.1%	8	
86-47	R207, R214 R221, R228 R307, R314 R321, R328			MEC	RESISTOR, Precision per MEC Dwg. A1007F6A1 245K ±.1%	8	
86-48	R229, R230 R231, R232			MEC	RESISTOR, Precision per MEC Dwg. A1007F6A1 750K ±.1%	4	
86-49	R201, R203 R208, R210 R215, R217 R222, R224 R301, R303 R308, R310 R315, R317 R322, R324			Helipot AR50K	POTENTIOMETER, Precision, 50K ±.25%	16	

1	2	3		4	5	6	7	8
ITEM NO.	REFER. DESIG-NATOR	CLASS	STOCK NO.	MFG. AND PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNIT PER ASSY.	PROCURE-MENT CODE	UNIT COST (EST.)
86-50	S1, S2, S101 S102			Acro 3D05-5P	SWITCH, Push button	4		2.45
86-51	S3, S103			Carling 2GL63-73	SWITCH, Toggle, DPDT	2		1.63
86-52	S201, S203 S205, S207 S301, S303 S305, S307			Carling 2GM63-73	SWITCH, Toggle, DPDT	8		1.31
86-53	S202, S204 S206, S208 S302, S304 S306, S308			Grayhill 24002-3	SWITCH, Precision, fully enclosed tap, 3 positions 3 positions, break 1 amp 115 VAC	8		6.16
86-54	V1, V6 V101, V106			Comm. 6072	TUBE, Electron	4		7.75
86-55	V2, V7 V102, V107			Comm. 6AU8A	TUBE, Electron	4		2.20
86-56	V3, V103			Comm. 5965 or 12AT7	TUBE, Electron	2		3.36
57	V4, V5, V8 V9, V104, V105, V107 V109			Comm. 5654	TUBE, Electron	8		5.04
86-58	XC6, XC14 XC106, XC114, XK51, XK151			JAN TS101P01	SOCKET, Octal, Tube, Mica filled	6		.84
86-59	XDS1, XDS2 XDS101 XDS102			Eldema 1DH6-4591	HOLDER, Lamp, with translucent lens	4		2.06

1	2	3		4	5	6	7	8
ITEM NO.	REFER. DESIG-NATOR	CLASS	STOCK NO.	MFG. AND PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNIT PER ASSY.	PROCURE-MENT CODE	UNIT COST (EST.)
86-60	XI1, XI101			Eldema 1DH6-4594	HOLDER, Lamp with green lens	2		2.06
86-61	XK1, XK4			Eby 9759-5	SOCKET, Tube, Miniature, 14 Pin	4		.79
86-62	XV1, XV6 XV101, XV106			JAN TS103C01	SOCKET, 9 Pin Miniature, Ceramic filled, with shield base	4		1.01
86-63	XV2, XV3, XV7, XV102 XV103, XV107			JAN TS103P01	SOCKET, 9 Pin Miniature, Mica filled, with shield base	6		.65
86-64	XV4, XV5, XV8, XV9 XV104, XV105 XV108, XV109			JAN TS102P01	SOCKET, 7 Pin Miniature, Mica filled, with shield base	8		.49
86-65				Helipot Type RB	DUO-DIAL	16		8.05

1	2	3		4	5	6	7
ITEM NO.	REFER. DESIG-NATOR	CLASS	STOCK NO.	MFG. AND PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNIT PER ASSY.	PROCURE-MENT CODE
86-1				MEC 1580-86A	ASSEMBLY, CONTROL	1	
86-2	C1, C9			Cornell Dubilier BYA10D22	CAPACITOR, Fixed ceramic, 2200$\mu\mu$f 1000 vdc	2	
86-3	C2, C6, C10, C14 C18, C20 C104, C301			Cornell Dubilier PM4P1	CAPACITOR, Fixed Mylar, .1μf, 400 vdc	8	
86-4	C3, C11			Cornell Dubilier SRE	CAPACITOR, Electrolytic, 50μf 6 vdc Bantam	2	
86-5	C4, C7 C12, C15			Cornell Dubilier PM4S1	CAPACITOR, Fixed Mylar, .01μf 400 vdc	4	
86-6	C5, C13			MIL DM-15-330K	CAPACITOR, Fixed Dur-Mica, 33$\mu\mu$f 500 vdc	2	
86-7	C17, C19			Cornell Dubilier SRE	CAPACITOR, Electrolytic, 50μf 12 vdc Bantam	2	
86-8	C8, C16 C105			Aerovox JP616MCB	CAPACITOR, Fixed, 1μf 600 vdc	3	
86-9	C101 C102			Mallory 20-71860	CAPACITOR, Computer Grade, 3000μf 75 vdc (2-1/16 Dia. x 4-1/2) with Acetate Sleeve.	2	
86-10	C103 C108			Fansteel F308-1	CAPACITOR, Blu-cap, 100μf 30 vdc	2	
86-11	C106			Aerovox AEP88J	CAPACITOR, Dual, 40-40μf 450 vdc	1	
86-12	C107			Cornell Dubilier PM4P5	CAPACITOR, Fixed Mylar, .5μf 400 vdc	1	
86-13	C302			Cornell Dubilier PM4S5	CAPACITOR, Fixed Mylar, .05μf 400 vdc	1	

1	2	3		4	5	6	7
ITEM NO.	REFER. DESIG-NATOR	CLASS	STOCK NO.	MFG. AND PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNIT PER ASSY.	PROCURE-MENT CODE
86-14	C21, C22			MIL DM-15-100K	CAPACITOR, Dur-Mica, 10$\mu\mu$f 500 vdc	2	
86-15	CR1-CR4 CR213 CR14 CR15			G.E. IN1692	DIODE	7	
86=16	CR101			G.E. 4JA211BB1AG1	RECTIFIER	1	
86-17	CR201-CR212			Transitron IN1693	DIODE	12	
86-18	DS1, DS2, DS201, DS202			Eldema 1CG12-4535	LAMP, Neon to Spec. 21C-3864-7	4	
86-19	I201			Eldema 1CF12-4589	LAMP, Incandescent, (28V)	1	
86-20	K1			Stevens Arnold CH-792	CHOPPER	1	
86-21	K201-K203			C.P. Clare RP-4461-G28	RELAY, 4 Form c	4	
86-22	K205-K208			C.P.Clare RP-7641-G8	RELAY, Type F	4	
86-23	L101			U.T.C. VIC-20	INDUCTOR, Variable	1	
86-24	N1			MEC TN-60	TRANSISTOR NETWORK	1	
86-25	N2			MEC RN-23B	RESISTOR NETWORK	1	

1	2	3		4	5	6	7
ITEM NO.	REFER. DESIG-NATOR	CLASS	STOCK NO.	MFG. AND PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNIT PER ASSY.	PROCURE-MENT CODE
86-26	P2			Amphenol MS3102A-36-10P	CONNECTOR	1	
86-27	P1			Amphenol MS3102A-28-12P	CONNECTOR	1	
86-28	R2, R30			MIL RC20GF204J	RESISTOR, Fixed composition, 200K ±5% 1/2W	2	
86-29	R3, R31			MIL RC20GF155J	RESISTOR, Fixed composition, 1.5M ±5% 1/2W	2	
86-30	R4, R32			MIL RC20GF513J	RESISTOR, Fixed composition, 51K ±5% 1/2W	2	
86-31	R8, R36 R211-R213			MIL RC20GF274K	RESISTOR, Fixed composition, 270K ±10% 1/2W	5	
86-32	R6, R34			MIL RC20GF185K	RESISTOR, Fixed composition, 1.8M ±10% 1/2W	2	
86-33	R7, R35			Allen Bradley JLU-5041 or JA1L040S504UC	POTENTIOMETER, 500K, Linear Taper	2	
86-34	R9, R38			MIL RC20GF683K	RESISTOR, Fixed composition, 68K ±10% 1/2W	2	
86-35	R10, R37			MIL RC20GF473K	RESISTOR, Fixed composition, 47K ±10% 1/2W	2	
86-36	R11, R39			MIL RC20GF365J	RESISTOR, Fixed composition, 3.6M ±5% 1/2W	2	
86-37	R12, R40			MIL RC20GF824K	RESISTOR, Fixed composition, 820K ±10% 1/2W	2	
86-38	R13, R41			MIL RC32GF222K	RESISTOR, Fixed composition, 2200Ω ±10% 1W	2	

1	2	3		4	5	6	7
ITEM NO.	REFER. DESIG-NATOR	CLASS	STOCK NO.	MFG. AND PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNIT PER ASSY.	PROCURE-MENT CODE
86-39	R1, R14, R29, R42 R63, R65			MIL RC20GF105K	RESISTOR, Fixed composition, 1M ±10% 1/2W	6	
86-40	R15, R20 R43, R48			MIL RC20GF225K	RESISTOR, Fixed composition, 2.2M ±10% 1/2W	4	
86-41	R16, R22 R44, R50			MIL RC20GF272K	RESISTOR, Fixed composition, 2700Ω ±10% 1/2W	4	
86-42	R17, R21 R23, R45 R49, R51			MIL RC20GF334K	RESISTOR, Fixed composition, 330K ±10% 1/2W	6	
86-43	R18, R24 R46, R52			MIL RC20GF623J	RESISTOR, Fixed composition, 62K ±5% 1/2W	4	
86-44	R19, R25 R47, R53 R61, R62			MIL RC20GF154K	RESISTOR, Fixed composition, 150K ±10% 1/2W	6	
86-45	R26, R54			MIL RC20GF104K	RESISTOR, Fixed composition, 100K ±10% 1/2W	2	
86-46	R27, R55			MIL RC20GF474K	RESISTOR, Fixed composition, 470K ±10% 1/2W	2	
86-47	R28, R56			MIL RC20GF107K	RESISTOR, Fixed composition, 100M ±10% 1/2W	2	
86-48	R64, R66 R214-R217			MIL RC20GF103K	RESISTOR, Fixed composition, 10K ±10% 1/2W	6	
86-49	*R57-R60			MIL RC42GF823K	RESISTOR, Fixed composition, 82K ±10% 2W	4	
86-50	*			NOTE	R57, R58, R59 and R60 are not installed when RN23B is used.		

1	2	3		4	5	6	7	8
ITEM NO.	REFER. DESIG-NATOR	CLASS	STOCK NO.	MFG. AND PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNIT PER ASSY.	PROCURE-MENT CODE	UNIT COST (EST.)
86-51	R67			Sprague 151E	RESISTOR, Fixed, 12Ω, 3W, ±10%	1		.71
86-52	R101 R102			IRC PW7	RESISTOR, 1.0Ω, 7W	2		.46
86-53	R103			MIL RC20GF392K	RESISTOR, Fixed Composition, 3.9K, ±10%, 1/2W	1		.17
86-54	R104			MIL RC42GF270K	RESISTOR, Fixed Composition, 27Ω, ±10%, 2W	1		.34
86-55	R105			MIL RC42GF120K	RESISTOR, Fixed Composition, 12Ω, ±10%, 2W	1		.34
86-56	R106			Ward Leonard 10F150	RESISTOR, Fixed Wire Wound, 150Ω, 10W	1		.80
86-57	R108			Ward Leonard 10F5000	RESISTOR, Fixed Wire Wound, 5K, 10W	1		.85
86-58	R109			Ward Leonard 5X50	RESISTOR, Fixed Axiohm, 50Ω, 5W	1		.87
86-59	R201 R202			MIL RC20GF563K	RESISTOR, Fixed Composition, 56K, ±10%, 1/2W	2		.17
86-60	R203-R206			MIL RC20GF564K	RESISTOR, Fixed Composition, 560K, ±10%, 1/2W	4		.17
86-61	R207 R208			MIL RC20GF152K	RESISTOR, Fixed Composition, 1500Ω, ±10%, 1/2W	2		.17
86-62	R209 R210			MIL RC20GF823K	RESISTOR, Fixed Composition, 82K, ±10%, 1/2W	2		.17
86-63	R110			MIL RC42GF104K	RESISTOR, Fixed Composition, 100K, 10%, 2W	1		.34
86-64	R5, R33			MIL RC20GF394K	RESISTOR, Fixed Composition, 390K, ±10%, 1/2W	2		.17

1	2	3		4	5	6	7	8
ITEM NO.	REFER. DESIG-NATOR	CLASS	STOCK NO.	MFG. AND PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNIT PER ASSY.	PROCURE-MENT CODE	UNIT COST (EST.)
86-65	R68			MIL RC32GF755J	RESISTOR, Fixed Composition, 7.5M, 5%, 1W	1		
86-66	R69			MIL RC32GF100K	RESISTOR, Fixed Composition, 10Ω, ±10%, 1W	1		
86-67	S1, S2			Acro 3D05-5P	SWITCH, Pushbutton	2		
86-68	S201-S203 S208-S211			Carling 2GL63-73	SWITCH, Toggle DPDT, on-none—on nickel plated bat Handle, Solder Lugs, 6A/125VAC, 3A/250 VAC.	7		
86-69	S204—S207 S214, S215			Centralab PA-2001	SWITCH, Rotary	6		
86-70	S212, S213			Cutler-Hammer 7665K4	SWITCH, Toggle, 4PDT, Bright Nickel Handle	2		
86-71	T101			Triad HSM-236	TRANSFORMER	1		
86-72	T201			Superior 20	POWERSTAT, 120V, 60 cps, 3 Amp	1		
86-73	V3			Comm. 5965	TUBE, Electron	1		
86-73B	V1, V6			Comm. 6072	TUBE, Electron	2		
86-74	V2, V7			Comm. 6AU8A	TUBE, Electron	2		
86-75	V4, V5, V8, V9			Comm. 5654	TUBE, Electron	4		
86-76	V101			Comm. OB2	TUBE, Electron	1		
86-77	XC106, XK1 XN1, XN2			JAN TS101O01	SOCKET, Octal, Mica filled	4		

1	2	3		4	5	6	7
ITEM NO.	REFER. DESIG-NATOR	CLASS	STOCK NO.	MFG. AND PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNIT PER ASSY.	PROCURE-MENT CODE
86-78	XDS1 XDS2 XDS201 XDS202 XI201			Eldema 11H4593	INDICATOR HOLDER	5	
86-79	XV2 XV3 XV7			JAN TS102P01	SOCKET, 9 Pin Miniature, Mica filled	3	
86-80	XV1 XV6			JAN TS103G01	SOCKET, 9 Pin Miniature, Ceramic	2	
86-81	XV4 XV5 XV9 XV101			JAN TS102P01	SOCKET, 7 Pin Miniature, Mica filled	5	
86-82	XK201- XK204			Eby 9759-5	SOCKET, 14 Pin	4	
86-83	XK205- XK208			C.P. Clare RP-9005	SOCKET, Relay, with RP-9006 Retaining Ring.	4	
86-84				Whitso K105	KNOB	7	
86-85				Eldema 11H-4110	LENS CAP (Translucent)	2	
86-86				Eldema 11H-4119	LENS CAP (Red)	2	
86-87				Eldema 11H-4118	LENS CAP (Amber)	1	

1 ITEM NO.	2 REFER. DESIG-NATOR	3 CLASS	3 STOCK NO.	4 MFG. AND PART NO.	5 DESCRIPTION 1 2 3 4 5 6 7	6 UNIT PER ASSY.	7 PROCURE-MENT CODE
86-1				MEC 1576-86C	Assembly, Auxiliary Control	1	
86-2	C1,C2			Cornell Dubilier PM4P1	Capacitor, Fixed Mylar, .1uf, 400vdc	2	
86-3	C3,C4			Cornell Dubilier NLW20-15	Capacitor, Electrolytic, 20uf, 15 vdc	2	
86-4	C5			Fansteel F308-1	Capacitor, (Blu-Cap) 100uf, 30vdc	1	
86-5	CR1 CR8			Fansteel BH1007	Rectifier	2	
86-6	CR2-CR5			Transifron IN1693	Diode	4	
86-7	CR6,CR7			GE IN1692	Diode	2	
86-8	CR9			International Rectifier 1Z27	Diode	1	
86-9	K1-K4			MEC RY-12	Relay (Mercury Wetted)	4	
86-10	N1,N2			MEC TN-46	Transistor Network	2	

1	2	3		4	5	6	7
ITEM NO.	REFER. DESIG-NATOR	CLASS	STOCK NO.	MFG. AND PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNIT PER ASSY.	PROCURE-MENT CODE
86-11	P1			Cannon MS3102A-28-15PY	Connector	1	
86-12	P2			Cannon MS3102A-18-4P	Connector	1	
86-13	R1,R9 R17, R26			MIL RC20GF102K	Resistor, Fixed Composition, 1K, ±10%, ½W	4	
86-14	R2, R10			MIL RC42GF204J	Resistor, Fixed Composition, 200K, ±5%, 2W	2	
86-15	R3, R4 R6, R8			MIL RC20GF105K	Resistor, Fixed Composition, 1M, ±10%, ½W	4	
86-16	R5, R7			Allen Bradley CLU-2531	Potentiometer, 25K, 2W, Linear Taper	2	
86-17	R11-R14			MIL RC20GF222K	Resistor, Fixed Composition, 2.2K, ±10% ½W	4	
86-18	R15, R30			MIL RC20GF104K	Resistor, Fixed Composition, 100K, ±10% ½W	2	
86-19	R16, R29			MIL RC20GF203J	Resistor, Fixed Composition, 20K, ±5%, ½W	2	

1	2	3		4	5	6	7
ITEM NO.	REFER. DESIG-NATOR	CLASS	STOCK NO.	MFG. AND PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNIT PER ASSY.	PROCURE-MENT CODE
86-20	R18, R27			MIL RC42GF224K	Resistor, Fixed Composition, 220K, ±10% 2W	2	
86-21	R19, R28			MIL RC20GF682K	Resistor, Fixed Composition, 6.8K, ±10%, ½W	2	
86-22	R20, R23			MIL RC20GF473K	Resistor, Fixed Composition, 47K, ±10%, ½W	2	
86-23	R21, R24			Allen Bradley CLU-5031	Potentiometer, 50K, 2W, Linear Taper	2	
86-24	R22, R25			MIL RC20GF503K	Resistor, Fixed Composition, 50K, ±10%, ½W	2	
86-25	R31			Ward Leonard 25F15,000	Resistor, Wire Wound, 15K, ±5%, 25W	1	
86-26	XK1-XK4 XN1 XN2			JAN TS101P01	Socket, Octal, Mica Filled	6	
86-27	R32			MIL RC20GF223K	Resistor, Fixed Composition, 22K, ±10%, ½W	1	

1	2	3		4	5	6	7
ITEM NO.	REFER. DESIG-NATOR	CLASS	STOCK NO.	MFG. AND PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNIT PER ASSY.	PROCURE-MENT CODE
72-1				MEC 15-72A	ASSEMBLY, SERVO SUPPLY	1	
72-2	C1, C2, C4, C5, C7, C8, C10, C11, C16, C18, C19			Cornell Dubilier PM4S1	CAPACITOR, Fixed, Molded Mylar, .01μf 400 V	11	
72-3	C3, C9, C7			Arco DM20-22K	CAPACITOR, Fixed, Dur-Mica, .0022μf ±10% 500 vdcw	3	
72-4	C6			Cornell Dubilier Type TWC10P1	CAPACITOR, Fixed, Miniature, Metal cased tubular .1μf 1000V	1	
72-5	C13			Cornell Dubilier YAB-6011	CAPACITOR, Fixed, Dual, Sealed metal case, .1 - .1μf, +20%-10%, 600V	1	
72-6	C15, C22			Cornell Dubilier PM4S47	CAPACITOR, Fixed, Molded Mylar, .047μf 400V	2	
72-7	C20			Cornell Dubilier Type TWC10P25	CAPACITOR, Fixed, Miniature, Metal cased tubular .25μf 1000 vdcw	1	
72-8	C21, C23, C24			Cornell Dubilier PM4P1	CAPACITOR, Fixed, Molded Mylar, .10μf 400 vdc	3	
72-9	C12			Cornell Dubilier Type TWC10S68	CAPACITOR, Fixed, Miniature, Metal cased tubular .068μf 1000V	1	
72-10	CR1-CR4			G.E. 1N1693	DIODE	4	
72-11	DS1			Eldema 1DH6-4591	HOLDER, Lamp with translucent lens	1	
72-12				Eldema 1CG12-4535	BULB, Neon, Per Spec. 21C-3864-7	1	

1	2	3		4	5	6	7
ITEM NO.	REFER. DESIG-NATOR	CLASS	STOCK NO.	MFG. AND PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNIT PER ASSY.	PROCURE-MENT CODE
72-13	F1			Littlefuse Type 3AB	FUSE, 3A	1	
72-14	F2, F3			Littlefuse Type 3AB	FUSE, 15A	2	
72-15	F4			Littlefuse Type 3AG	FUSE, 1/2A	1	
72-16	F5			Littlefuse Type 3AG	FUSE, 1/4A	1	
72-17	F6			Littlefuse Type 3AG	FUSE, 1A	1	
72-18	K1, K2			Airpax Type 300	CHOPPER, Frequency, 400 cps	2	
72-19	L1			UTC VIC-14	CHOKE	1	
72-20	R1, R21			MIL RC32GF821K	RESISTOR, Fixed composition, 820Ω ±10% 1W	2	
72-21	R2, R22			MIL RC20GF273K	RESISTOR, Fixed composition, 27K ±10% 1/2W	2	
72-22	R3, R23			MIL RC20GF123K	RESISTOR, Fixed composition, 12K ±10% 1/2W	2	
72-23	R4, R24			MIL RC20GF334K	RESISTOR, Fixed composition, 330K ±10% 1/2W	2	
72-24	R6, R10, R26, R30, R42, R46			MIL RC20GF105K	RESISTOR, Fixed composition, 1.0M ±10% 1/2W	6	
72-25	R7, R12, R13, R27, R32, R33 R43, R48, R49 R70, R62, R64, R79			MIL RC20GF104K	RESISTOR, Fixed composition, 100K ±10% 1/2W	13	

1	2	3		4	5	6	7
ITEM NO.	REFER. DESIG-NATOR	CLASS	STOCK NO.	MFG. AND PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNIT PER ASSY.	PROCURE-MENT CODE
72-26	R8, R28			MIL RC20GF562K	RESISTOR, Fixed composition, 5.6K ±10% 1/2W	2	
72-27	R9, R29, R45, R61, R63, R69, R78			Allen Bradley JLU 5041 or JA1L040S504UC	POTENTIOMETER, Variable, composition, linear taper, 500K ±10% 2W	7	
72-28	R11, R31, R5, R25, R47			MIL RC20GF272K	RESISTOR, Fixed composition, 2.7K ±10% 1/2W	5	
72-29	R14, R15, R34, R35, R50, R51, R53			MIL RC20GF274K	RESISTOR, Fixed composition, 270K ±10% 1/2W	7	
72-30	R16			Ward Leonard 5F150	RESISTOR, Fixed, Wire wound, 150Ω 5W	1	
72-31	R17, R37			MIL RC20GF106K	RESISTOR, Fixed composition, 10M ±10% 1/2W	2	
72-32	R18, R38			MIL RC20GF824K	RESISTOR, Fixed composition, 820K ±10% 1/2W	2	
72-33	R19, R39			MIL RC32GF101K	RESISTOR, Fixed composition, 100Ω ±10% 1W	2	
72-34	R40			MIL RC42GF102K	RESISTOR, Fixed composition, 1.0K ±10% 2W	1	
72-35	R36			Ward Leonard 5X300	RESISTOR, Fixed, Wire wound, 300Ω Axiohm 5W	1	
72-36	R41			MIL RC20GF474K	RESISTOR, Fixed composition, 470K ±10% 1/2W	1	
72-37	R44, R68, R77			MIL RC20GF155K	RESISTOR, Fixed composition, 1.5M ±10% 1/2W	3	

1	2	3		4	5	6	7
ITEM NO.	REFER. DESIG-NATOR	CLASS	STOCK NO.	MFG. AND PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNIT PER ASSY.	PROCURE-MENT CODE
72-38	R52			MIL RC20GF475K	RESISTOR, Fixed composition, 4.7M ±10% 1/2W	1	
72-39	R55, R56			MIL RC42GF104K	RESISTOR, Fixed composition, 100K ±10% 2W	2	
72-40	R57-R60, R20			MIL RC32GF221K	RESISTOR, Fixed composition, 220Ω ±10% 1W	5	
72-41	R97, R98			MIL RC20GF333K	RESISTOR, Fixed composition, 33K ±10% 1/2W	2	
72-42	R65, R66, R74, R75			MIL RC20GF222K	RESISTOR, Fixed composition, 2.2K ±10% 1/2W	4	
72-43	R67, R76			MIL RC42GF334K	RESISTOR, Fixed composition, 330K ±10% 2W	2	
72-44	R72, R81			MIL RC20GF682K	RESISTOR, Fixed composition, 6.8L ±10% 1/2W	2	
72-45	R73, R80			MIL RC42GF822K	RESISTOR, Fixed composition, 8.2K ±10% 2W	2	
72-46	R82-R85			Ward Leonard 5X35	RESISTOR, Fixed, Wire wound, Axiohm, 35Ω 5W	4	
72-47	R86, R92			MIL RC20GF103K	RESISTOR, Fixed composition, 10K ±10% 1/2W	2	
72-48	R87			MIL RC32GF564K	RESISTOR, Fixed composition, 560K ±10% 1W	1	
72-49	R54			MIL RC32GF274K	RESISTOR, Fixed composition, 270K ±10% 1W	1	
72-50	R91			MIL RC20GF433J	RESISTOR, Fixed composition, 43K ±5% 1/2W	1	
72-51	R93			MIL RC20GF513J	RESISTOR, Fixed composition, 51K ±5% 1/2W	1	

1	2	3		4	5	6	7
ITEM NO.	REFER. DESIG-NATOR	CLASS	STOCK NO.	MFG. AND PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNIT PER ASSY.	PROCURE-MENT CODE
72-52	R94			MIL RC20GF303J	RESISTOR, Fixed composition, 30K ±5% 1/2W	1	
72-53	R95, R96			MIL RC20GF225K	RESISTOR, Fixed composition, 2.2M ±10% 1/2W	2	
72-54	S72			MIL MS3102A32-7P	CONNECTOR	1	
72-55	T1, T3			Hermetic Seal 956-0280-200 or TTI 5298	TRANSFORMER, Servo input, primary CT, stepup ratio 5: 1, 60 cycles 90db shielding insulation resistance 10° megohms minimum	2	
72-56	T5			TTI 4683	TRANSFORMER, Power output, primary 3500Ω CT, secondary 255/75/25/8 Ω class B, push-pull 250 W, JAN TF1RX21LA	1	
72-57	T2, T4			TTI 4444	TRANSFORMER, output 40 W, primary 9000Ω CT secondary 25/75/225 Ω	2	
72-58	T6			TTI 4300	TRANSFORMER, Filament	1	
72-59	V1, V2, V5, V6, V9, V10			Comm. 12AX7	TUBE, Electron	6	
72-60	V3, V4, V12-V15			Comm. 6550	TUBE, Electron	6	
72-61	V7, V8			Comm. 5881	TUBE, Electron	2	
72-62	V11			Comm. 12AU7	TUBE, Electron	1	
72-63	V16, V17			Comm. 5965 or 12AT7	TUBE, Electron	2	
72-64	XF1-XF6			Bussmann HKP	FUSE HOLDER	6	
72-65	XK1, XK2			JAN TS102P01	SOCKET, Tube, 7 Pin Miniature	2	

1	2	3		4	5	6	7
ITEM NO.	REFER. DESIG-NATOR	CLASS	STOCK NO.	MFG. AND PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNIT PER ASSY.	PROCURE-MENT CODE
72-66	XV1, XV2, XV5, XV6, XV9-XV11, XV16, XV17			JAN TS103P01	SOCKET, Tube, 9 Pin Miniature	9	
72-67	XV3, XV4, XV7, XV8, XV12-XV15			JAN TS101P01	SOCKET, Octal, Miniature, Mica filled	8	

1	2	3		4	5	6	7
ITEM NO.	REFER. DESIG-NATOR	CLASS	STOCK NO.	MFG. AND PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNIT PER ASSY.	PROCURE-MENT CODE
71-1				MEC E15A71A	ASSEMBLY, Power Supply	1	
71-2	C1, C2			Mallory 20-71948	CAPACITOR, Electrolytic commercial computer grade 200μf, 450V, 2-1/16 dia. x 4-1/2 can with acetate sleeve, high post, class VI	2	
71-3	C3, C4 C6-C8			Mallory 20-71853	CAPACITOR, Electrolytic commercial computer grade 400μf, 350V, 2-1/16 dia. x 4-1/2 can with acetate sleeve, high post, class VI	5	
71-4	C5			Cornell Dublier PM4P1	CAPACITOR, Fixed, molded Mylar, .1μf, 400vdc	1	
71-5	C9			Aerovox AEP88J	CAPACITOR, Plug-In Electrolytic, 40μf x 40μf,	1	
71-6	CR1			General Electric 4JA411 DC5AD1	RECTIFIER, Silicon, single phase, center tap, 700V 60 cps sinusoidal input (line to center tap), 625Ω, 3.0 amp d-c output at 25°C	1	
71-7	CR2-CR5, CR7, CR8			Westinghouse 320P	DIODE, Silicon	5	
71-8	F1			Littlefuse Type 3AB	FUSE, 10A	1	
71-9	F2			Littlefuse Type 3AB	FUSE, 2A	1	
71-10	F3-F6			Littlefuse Type 3AB	FUSE, 15A	4	
71-11	L1			Freed 31365	CHOKE	1	
71-12	L2			Chicago RH-8105	CHOKE	1	
71-13	R1			Ward Leonard WL25F1500	RESISTOR, Fixed, Wire wound, 1.5K ±5% 25W	1	

1	2	3		4	5	6	7
ITEM NO.	REFER. DESIG-NATOR	CLASS	STOCK NO.	MFG. AND PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNIT PER ASSY.	PROCURE-MENT CODE
71-14	R2			Ward Leonard 10F20,000	RESISTOR, Fixed, Wire wound, 20K ±5% 10W	1	
71-15	R3			Ward Leonard 10F300	RESISTOR, Fixed, Wire wound, .300Ω ±5% 10W	1	
71-16	R4			MIL RC32GF101K	RESISTOR, Fixed composition, 100Ω ±10% 1W	1	
71-17	R5, R6, R12, R13			MIL RC20GF474K	RESISTOR, Fixed composition, 470K ±10% 1/2W	4	
71-18	R7			MIL RC20GF154K	RESISTOR, Fixed composition, 150K ±10% 1/2W	1	
71-19	R8			MIL RC42GF683K	RESISTOR, Fixed composition, 68K ±10% 2W	1	
71-20	R10			Chicago Tele. Supply FF18378	POTENTIOMETER, Variable, Wire wound, 20K ±10%, Linear Taper, locking type bushing 1/2" lg. slotted shaft, 4W, type 25	1	
71-21	R14			Ward Leonard 10F3000	RESISTOR, Fixed, Wire wound, 3000Ω ±5% 10W	1	
71-22	R15			MIL RC32GF333K	RESISTOR, Fixed composition, 33K ±10% 1W	1	
71-23	R22			MIL RC42GF221K	RESISTOR, Fixed composition, 220Ω ±10% 2W	1	
71-24	R9, R11			Weston 9852	RESISTOR, Fixed composition, Vamistor, 300K ±1% 1W	2	
71-25	R20			Ward Leonard 10F2000	RESISTOR, Fixed, Wire wound, 2000Ω ±5% 10W	1	
71-26	R21			Ward Leonard 10F4000	RESISTOR, Fixed, Wire wound, 4K ±5% 10W	1	

1	2	3		4	5	6	7
ITEM NO.	REFER. DESIG-NATOR	CLASS	STOCK NO.	MFG. AND PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNIT PER ASSY.	PROCURE-MENT CODE
71-27	S71			Cannon MS3102A32-13P	CONNECTOR	1	
71-28	T1			Freed 31364	TRANSFORMER, Plate, primary 110/115/120Vac secondary 1110Vac CT, 1.3 amps	1	
71-29	T2			Transformer Technicians 4300	TRANSFORMER, Filament, primary 105/115/125, AC 60 cps, secondary 6.4Vac at 10am. JAN TF1RX01KB	1	
71-30	V1			Comm. 6550	TUBE, Electron	1	
71-31	V2			Comm. 6BH6	TUBE, Electron	1	
71-32	V3, V4			Comm. 0D3	TUBE, Voltage regulator	2	
71-33	XC9, XV1, XV3, XV4			JAN TS101P01	SOCKET, Octal, Tube, Mica filled	4	
71-34	XV2			JAN TS102P01	SOCKET, 7 Pin Miniature, Mica filled	1	
71-35	XF1-XF6			Bussmann HKP	FUSE HOLDER	6	

1	2	3		4	5	6	7
ITEM NO.	REFER. DESIG-NATOR	CLASS	STOCK NO.	MFG. AND PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNIT PER ASSY.	PROCURE-MENT CODE
31-1				MEC 15-31A	ASSEMBLY, SERVO AMPLIFIER	1	
31-2	C1, C2, C4, C5, C7, C8, C10, C11, C18, C19			Cornell Dubilier PM4S1	CAPACITOR, Fixed, Molded Mylar, .01μf 400 V	10	
31-3	C3, C9			Cornell Dubilier BYA10D22	CAPACITOR, Fixed, Ceramic, .022μf 500 vdcw	2	
31-4	C6			Cornell Dubilier Type TWC10P1	CAPACITOR, Fixed, Miniature, Metal cased, tubular, .1μf 1000 vdcw	1	
31-5	C12			Cornell Dubilier Type TWC10S68	CAPACITOR, Fixed, Miniature, Metal cased, tubular, .068μf 1000 Vdcw	1	
31-6	C13-C16, C21			Cornell Dubilier PM4P1	CAPACITOR, Fixed, Molded Mylar, .10μf 400 vdc	5	
31-7	C17			Cornell Dubilier PM6D5	CAPACITOR, Fixed, Molded Mylar, .005μf 600 vdc	1	
31-8	C20			Cornell Dubilier PM4S68	CAPACITOR, Fixed, Molded Mylar, .068μf 400 vdc	1	
31-9	C22			Cornell Dubilier PM4S5	CAPACITOR, Fixed, Molded Mylar, .05μf 400 vdc	1	
31-10	C23			Cornell Dubilier Type TWC4P47	CAPACITOR, Fixed, Molded Mylar,	1	
31-11	CR1-CR4			G.E. 1N1693	DIODE	4	
31-12	F1			Littlefuse Type 3AG	FUSE, 1/2A	1	
31-13	F2			Littlefuse Type 3AG	FUSE, 1/4A	1	

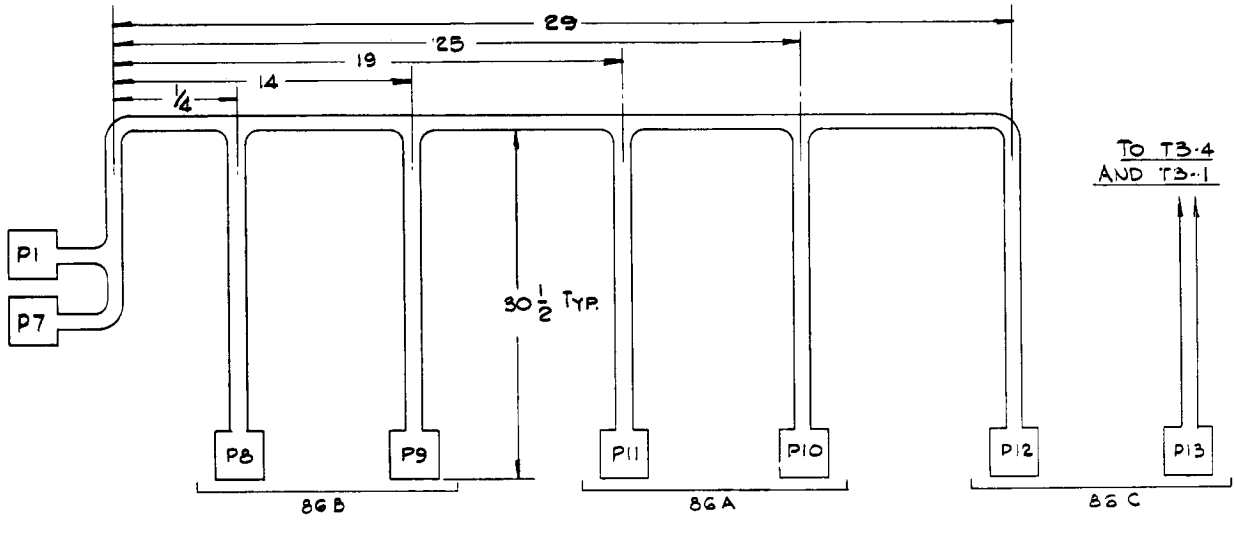
1	2	3		4	5	6	7
ITEM NO.	REFER. DESIG-NATOR	CLASS	STOCK NO.	MFG. AND PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNIT PER ASSY.	PROCURE-MENT CODE
31-14	K1-K3			Airpax Type 300	CHOPPER	3	
31-15	K4			C.P. Clare B62104	RELAY, 100,000Ω coil, one form C, type R	1	
31-16	R1, R21			MIL RC32GF821K	RESISTOR, Fixed composition, 820Ω ±10% 1W	2	
31-17	R2, R22			MIL RC20GF273K	RESISTOR, Fixed composition, 27K ±10% 1/2W	2	
31-18	R3, R23			MIL RC20GF123K	RESISTOR, Fixed composition, 12K ±10% 1/2W	2	
31-19	R4, R24			MIL RC20GF334K	RESISTOR, Fixed composition, 330K ±10% 1/2W	2	
31-20	R6, R10, R26, R30, R70, R71, R73			MIL RC20GF105K	RESISTOR, Fixed composition, 1.0M ±10% 1/2W	7	
31-21	R7, R27, R12, R13, R32, R33, R46, R55, R62, R64, R72, R74			MIL RC20GF104K	RESISTOR, Fixed composition, 100K ±10% 1/2W	12	
31-22	R8, R28			MIL RC20GF562K	RESISTOR, Fixed composition, 5600Ω ±10% 1/2W	2	
31-23	R9, R29, R45, R54, R61, R63			Allen Bradley JLU 5041 or	POTENTIOMETER, Variable, Composition, Linear taper, 500K ±10% 2W	6	
31-24	R11, R31, R5, R25			MIL RC20GF272K	RESISTOR, Fixed composition, 2.7K ±10% 1/2W	4	

1	2	3		4	5	6	7
ITEM NO.	REFER. DESIG-NATOR	CLASS	STOCK NO.	MFG. AND PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNIT PER ASSY.	PROCURE-MENT CODE
31-25	R14, R15, R34, R35			MIL RC20GF274K	RESISTOR, Fixed composition, 270K ±10% 1/2W	4	
31-26	R16			Ward Leonard 5X150	RESISTOR, Fixed, Wire wound, 150Ω, Axiohm, 5W	1	
31-27	R17, R37			MIL RC20GF106K	RESISTOR, Fixed composition, 10M ±10% 1/2W	2	
31-28	R18, R38			MIL RC20GF824K	RESISTOR, Fixed composition, 820K ±10% 1/2W	2	
31-29	R19, R39			MIL RC32GF101K	RESISTOR, Fixed composition, 100Ω ±10% 1W	2	
31-30	R20			MIL RC32GF221K	RESISTOR, Fixed composition, 220Ω ±10% 1W	1	
31-31	R36			Ward Leonard 5X300	RESISTOR, Fixed, Wire wound, 300Ω, Axiohm, 5W	1	
31-32	R40			MIL RC42GF102K	RESISTOR, Fixed composition, 1.0K ±10% 2W	1	
31-33	R41, R42, R50, R51			MIL RC20GF222K	RESISTOR, Fixed composition, 2.2K ±10% 1/2W	4	
31-34	R44, R53			MIL RC20GF155K	RESISTOR, Fixed composition, 1.5M ±10% 1/2W	2	
31-35	R49, R58			MIL RC42GF822K	RESISTOR, Fixed composition, 8.2K ±10% 2W	2	
31-36	R48, R57			MIL RC20GF682K	RESISTOR, Fixed composition, 6.8K ±10% 1/2W	2	
31-37	R65, R66, R69			MIL RC20GF474K	RESISTOR, Fixed composition, 470K ±10% 1/2W	3	
31-38	R67			Ward Leonard 10F6000	RESISTOR, Fixed, Wire wound, 6000Ω, 10W	1	

1	2	3		4	5	6	7
ITEM NO.	REFER. DESIG-NATOR	CLASS	STOCK NO.	MFG. AND PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNIT PER ASSY.	PROCURE-MENT CODE
31-53	XV3, XV4, XV7, XV8			JAN TS101P01	SOCKET, Octal, Tube, Mica filled	4	
31-39	R68			MIL RC20GF476K	RESISTOR, Fixed composition, 47M ±10% 1/2W	1	
31-40	R75, R78			MIL RC20GF225K	RESISTOR, Fixed composition, 2.2M ±10% 1/2W	2	
31-41	R76			MIL RC20GF103K	RESISTOR, Fixed composition, 10K ±10% 1/2W	1	
31-42	R77			MIL RC32GF564K	RESISTOR, Fixed composition, 560K ±10% 1W	1	
31-43	R79, R80			MIL RC42GF334K	RESISTOR, Fixed composition, 330K ±10% 2W	2	
31-44	S31			Cannon MS3102A28-15P	CONNECTOR	1	
31-45	T1, T3			TTI 5298 or Hermetic Seal 956-0280-200	TRANSFORMER, Servo output, primary, 9000Ω, CT, secondary 225/75/25Ω 40W, JAN4RX13GA	2	
31-46	T2, T4			TTI 4444 or Hermetic Seal 956-0195-200	TRANSFORMER, output 40W, primary 9000Ω, CT secondary 25/75/225Ω	2	
31-47	V1, V2, V5, V6, V11			Comm. 12AX7	TUBE, Electron	5	
31-48	V3, V4			Comm. 6550	TUBE, Electron	2	
31-49	V7, V8			Comm. 5881	TUBE, Electron	2	
31-50	V9, V10,			Comm. 5965 or 12AT7	TUBE, Electron	3	
31-51	XK1-XK3			JAN TS102P01	SOCKET, 7 Pin Miniature, Mica filled	3	
31-52	XV1, XV2, XV5, XV6, XV9-XV12			JAN TS103P01	SOCKET, 9 Pin Miniature, Mica filled	8	

1	2	3		4	5	6	7
ITEM NO.	REFER. DESIG-NATOR	CLASS	STOCK NO.	MFG. AND PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNIT PER ASSY.	PROCURE-MENT CODE
3-1				MEC Model 15-3A	ASSEMBLY, PLOTTING BOARD	1	
3-2				MEC B15A3ABB	CABLE ASSEMBLY, Pen Carriage Contact	2	
3-3				MEC A15A3ABD	CABLE ASSEMBLY, Pen Carriage , Lower	2	
3-4				MEC B15A3ABC	CABLE ASSEMBLY, Pen Carriage, Upper	2	
3-5				MEC A15A3AG	ARM CABLE ASSEMBLY, Drive, Long	2	
3-6				MEC A15A3AH	ARM CABLE ASSEMBLY, Drive, Short	2	
3-7				MEC B15A3ABAE	PEN ASSEMBLY, Upper Left-hand and Lower right	2	
3-8				MEC E15MABAD5	INKWELL	2	
3-9				MEC B15A3ABAE	PEN ASSEMBLY, Upper Right and Lower Left	2	
3-10				MEC A15M3ABAE5	INKWELL	2	
3-11				MEC A15M3ABAC3	RELAY, Pen Lift	4	
3-12				G.M. Labs 66553-180	*MOTOR, Servo Drive, (High Speed), 400 cps	6	
3-13				G.M. Labs 66553-181	*MOTOR, Servo Drive, (Low Speed), 400 cps	6	
3-14				MEC A3010F37A2	POTENTIOMETER, Servo Feedback	4	
	*Specify serial number of Records when ordering motors.						
3-15				Sylvania Lumiline	LAMP, Plotting Surface, 40W, 120V	2	
3-16				Sylvania Lumiline	LAMP, Plotting Surface, 60W, 120V	2	
3-17				Gast 0211-V103-G8X	PUMP ASSEMBLY, Vacuum	1	

VI — A WIRE LIST



NOTES :~

1- DIMENSIONS BETWEEN CONNECTORS TO BE COMPATIBLE WITH PHYSICAL LOCATION OF SLIDE MOUNTED CONNECTORS IN MOD.1576, USING SLIDE COMPONENT CONFIGURATION IN SLOPING FRONT PANEL CONTROL AREA.

2- CABLES TO BE FLEXIBLE TO WORK WITH CHASSIS TRACK SLIDE ARRANGEMENT.

Figure 6-A-1. Cable Routing, X-Y Plotting Board, Dwg. #B1576W2A

DRAWN	DATE APPROVED FOR MFG. 5/27/60	C
CHECKED		
REVIEWED	REVISIONS	

P1
MAIN SIGNAL CONNECTOR
MS3106B36-7P (DAP)
W/MS3057-24

WIRE NO.	TERMINAL	DESTINATION	CABLE	IDENTIFICATION	WIRE SIZE	COLOR
	A	P10-A		$\emptyset_1$ In Fused	16	W-S
	B	P10-B		$\emptyset_2$ In Fused	16	S
	C	P10-C		60 cps AC Com.	18	W
	D	P10-D		$\emptyset_1$ Switched	16	W-S
	E	P10-E		$\emptyset_2$ Switched	16	S
	F	P10-F		Vacuum Pump Control	20	W-S
	G	P10-h		Arm 1 Lower Pen (Auto Pen Lift Voltage)	Coax	
	H	P10-L		Light Control	20	W-S
	I	P10-c		Arm 1 Lower Pen Control Signal	Coax	
	J	P10-f		X_1 Interchange Input	Coax	
	L	P10-U		Arm 1 Upper Pen (Auto Pen Lift Voltage)	Coax	
	M	P8-c		- Ref	18	W-V
	N	P10-d		X_1 Servo Input	Coax	
	O	P8-e		Chassis Ground	18	BK
	R	P10-T		Arm 1 Upper Pen Control Signal	Coax	
	S	P8-Y		Y_2 Input (#1)	Coax	
	T	P8-a		X_1 Input (#1)	Coax	
	V	P10-g		X_2 Interchange Input	Coax	
	W	P8-b		+ Ref	18	W-R
	X	P8-Z		Y_1 Input (#1)	Coax	
	Z	P10-b		Arm 2 Lower Pen (Auto Pen Lift Voltage)	Coax	

NOTES: Terminate one end of Coax shield to Chassis Ground Terminal
See B1576W2A for Cable Routing

MILGO ELECTRONIC CORPORATION
MIAMI 47, FLORIDA

WIRE LIST | A 1576WL2A SHEET 1 OF 23 SHEETS

DRAWN	DATE APPROVED FOR MFG. 5/27/60	C
CHECKED		
REVIEWED	REVISIONS	

P1
MAIN SIGNAL CONNECTOR
MS3106B36-7P (DAP)
W/MS 3057-24

WIRE NO.	TERMINAL	DESTINATION	CABLE	IDENTIFICATION	WIRE SIZE	COLOR
	a	P8-U		+300V Reg	22	R
	b	P10-u		Y_2 Servo Input	Coax	
	c	P10-w		Y_1 Servo Input	Coax	
	d	P10-a		Arm 2 Lower Pen Control Signal	Coax	
	e	P8-V		± Ground (B)	18	BK
	f	P8-W		-300V Reg	22	W
	g	P8-X		X_2 Input (#1)	Coax	
	h	P10-k		Arm 2 Upper Pen (Auto Pen Lift Voltage)	Coax	
	j	P10-j		Arm 2 Upper Pen Control Signal	Coax	
	k	P11-d		-450 Unreg.	22	S
	m	P10-e		X_2 Servo Input	Coax	
	n	P10-J		Interchange Relay Control (+Relay Voltage)	20	O
	p	P10-K		Interchange Relay Control	20	O
	r	P11-J		Ref. Input	18	G
	s	P8-F		Fil CT (Ground)	18	BK
	t	P8-B		Fil (Ground)	16	W-BR
	u	P8-A		Fil (-300V)	16	BR
	v	P8-G		Fil (Ground)	16	BR
	w	P8-C		Fil (-300V)	16	W-BR
	x	P10-Q		± Gnd (A)	18	BK
	y	P10-y		HQ Ground	16	BK
	y	P11-G		HQ Ground	18	BK

NOTES: See Sheet 1

MILGO ELECTRONIC CORPORATION
MIAMI 47, FLORIDA

WIRE LIST | A1576WL2A SHEET 2 OF 23 SHEETS

DRAWN	DATE APPROVED FOR MFG. 5-27-60	C RDyn	P1 MAIN SIGNAL CONNECTOR MS3106B36-7P (DAP) W/MS3057-24
CHECKED			
REVIEWED	REVISIONS		

WIRE NO.	TERMINAL	DESTINATION	CABLE	IDENTIFICATION	WIRE SIZE	COLOR
	y	P11-H		HQ Ground	18	BK
	z	P8-g		HQ Ground	18	BK
	z	P8-h		HQ Ground	18	BK
	z	P9-h		HQ Ground	18	BK
	z	P9-g		HQ Ground	18	BK

NOTES: See Sheet 1

MILGO ELECTRONIC CORPORATION
MIAMI 47, FLORIDA

WIRE LIST | A 1576WL2A SHEET 3 OF 23 SHEETS C

DRAWN	DATE APPROVED FOR MFG. 5-27-6[illegible]	C RDyn	P7 AUX. SIGNAL CONNECTOR MS3106B28-21P (DAP) W/MS3057-16
CHECKED			
REVIEWED	REVISIONS		

WIRE NO.	TERMINAL	DESTINATION	CABLE	IDENTIFICATION	WIRE SIZE	COLOR
	A	P9-Y		Y_2 Input (#2)	Coax	
	B	P9-X		X_2 Input (#2)	Coax	
	C	P9-Z		Y_1 Input (#2)	Coax	
	D	P9-a		X_1 Input (#2)	Coax	
	P	P10-Y		Timing Input Arm 1 Upper Pen	Coax	
	R	P10-W		Timing Input Arm 1 Lower Pen	Coax	
	S	P10-V		Timing Input Arm 2 Upper Pen	Coax	
	T	P10-R		Timing Input Arm 2 Lower Pen	Coax	
	U	P10-G		Timing Common	20	BK
	V	P11-F		Pen Control Signal Voltage	22	W-R
	W	P10-s		Pen Control Signal Voltage	22	W-BL
	a	P11-V		Relay #1 Control	20	O
	b	P11-W		Relay #2 Control	20	O
	c	P11-X		Relay #3 Control	20	O
	d	P11-L		Remote Relay Voltage	20	O
	e	P10-T		Arm 1 Upper Pen Control	Coax	
	f	P10-c		Arm 1 Lower Pen Control	Coax	
	g	P10-j		Arm 2 Upper Pen Control	Coax	
	h	P10-a		Arm 2 Lower Pen Control	Coax	
	j	P12-F		Pen Select Arm #1	20	GR

NOTES: See Sheet 1

MILGO ELECTRONIC CORPORATION
MIAMI 47, FLORIDA

WIRE LIST | A 1576WL2A SHEET 4 OF 23 SHEETS C

DRAWN	DATE APPROVED FOR MFG. 6-27-60	P7
CHECKED		AUX. SIGNAL CONNECTOR
REVIEWED	REVISIONS (1)	MS3106B28-21P (DAP) W/MS3057-16

WIRE NO.	TERMINAL	DESTINATION	CABLE	IDENTIFICATION	WIRE SIZE	COLOR
	k	P12-G		Pen Select Arm #2	20	GR
	m	P12-P		E.O.P.	20	BL
	n	P12-R		Standby Voltage	20	BL
	p	P11-a		#1 Arm Standby	20	BL
	r	P11-b		#2 Arm Standby	20	GR
	s	P12-V		± Gnd	18	BK

NOTES:
See Sheet 1

MILGO ELECTRONIC CORPORATION
MIAMI 47, FLORIDA

WIRE LIST | A 1576WL2A SHEET 5 OF 23 SHEETS

DRAWN	DATE APPROVED FOR MFG. 5-27-61	P8
CHECKED		SCALE FACTOR AND PX
REVIEWED	REVISIONS	MS3106B28-15S (DAP) W/MS3057-16(3032-86B P1)

WIRE NO.	TERMINAL	DESTINATION	CABLE	IDENTIFICATION	WIRE SIZE	COLOR
	A	P1-u		Fil (-300V)	16	BR
	A	P9-A		Fil (-300V)	16	BR
	B	P1-t		Fil (Gnd)	16	W-BR
	B	P9-B		Fil (Gnd)	16	W-BR
	C	P1-w		Fil (-300V)	16	W-BR
	C	P9-C		Fil (-300V)	16	W-BR
	D	P9-D		Chopper Drive (Hot)	22	S
	E	P9-E		Chopper Drive (Gnd)	22	BK
	F	P1-s		Fil CT (Gnd)	18	BK
	F	P9-F		Fil CT (Gnd)	18	BK
	G	P1-v		Fil (Gnd)	16	BR
	G	P9-G		Fil (Gnd)	16	BR
	H	P11-B		#1 Relay Control	20	O
	J	P9-J		Relay Ground	20	BK
	M	P11-T		-400V	22	S
	P	P10-g		Amp #1 Output (X_1)	22	W-O
	R	P10-p		Amp #2 Output (Y_1)	22	W-Y
	U	P1-a		+300V Regulated	22	R
	U	P11-Z		+300V Regulated	22	R
	V	P1-e		± Gnd (B)	18	BK
	V	P9-V		± Gnd (B)	18	BK
	W	P1-f		-300V Reg	22	W
	W	P11-S		-300V Reg	22	W
	X	P1-g		X_2 Input (#1)	Coax	

NOTES:
See Sheet 1

MILGO ELECTRONIC CORPORATION
MIAMI 47, FLORIDA

WIRE LIST | A 1576WL2A SHEET 6 OF 23 SHEETS

DRAWN | DATE APPROVED FOR MFG. 5-27-60 | C Ram

CHECKED | REVISIONS

REVIEWED

P8

SCALE FACTOR AND PX
MS3106B28-15S (DAP)
W/MS3057-16(3032-86B P1)

WIRE NO.	TERMINAL	DESTINATION	CABLE	IDENTIFICATION	WIRE SIZE	COLOR
	Y	P1-S		Y_2 Input (#1)	Coax	
	Z	P1-X		Y_1 Input (#1)	Coax	
	a	P1-T		X_1 Input (#1)	Coax	
	b	P1-W		+ Ref	18	W-R
	b	P10-t		+ Ref	18	W-R
	c	P1-M		- Ref	18	W-V
	c	P10-m		- Ref	18	W-V
	d	P12-m		Amp #2 Grid	Coax	
	e	P1-O		Chassis Gnd	18	BK
	e	P9-e		Chassis Gnd	18	BK
	g	P1-z		HQ Gnd	18	BK
	h	P1-z		HQ Gnd	18	BK

NOTES:
See Sheet 1

MILGO ELECTRONIC CORPORATION
MIAMI 47, FLORIDA

WIRE LIST | A 1576WL2A | SHEET 7 OF 23 SHEETS | C

DRAWN | DATE APPROVED FOR MFG. 5-27-60 | C Ram

CHECKED | REVISIONS

REVIEWED

P9

SCALE FACTOR AND PX
MS3106B28-15SX (DAP)
W/MS3057-16(3032-86B P2)

WIRE NO.	TERMINAL	DESTINATION	CABLE	IDENTIFICATION	WIRE SIZE	COLOR
	A	P8-A		Fil (-300V)	16	BR
	A	P11-R		Fil (-300V)	16	BR
	B	P8-B		Fil (Gnd)	16	W-BR
	B	P11-B		Fil (Gnd)	16	W-BR
	C	P8-C		Fil (-300V)	16	W-BR
	C	P11-P		Fil (-300V)	16	W-BR
	D	P8-D		Chopper Drive (Hot)	22	S
	D	P11-D		Chopper Drive (Hot)	22	S
	E	P8-E		Chopper Drive (Gnd)	22	BK
	E	P11-E		Chopper Drive (Gnd)	22	BK
	F	P8-F		Fil CT (Gnd)	18	BK
	F	P11-A		Fil CT (Gnd)	18	BK
	G	P8-G		Fil (Gnd)	16	BR
	G	P11-C		Fil (Gnd)	16	BR
	H	P11-W		#2 Relay Control	20	O
	J	P8-J		Relay Ground	20	BK
	J	P10-H		Relay Ground	20	BK
	S	P10-f		Amp #3 Output (X_2)	22	W-G
	T	P10-q		Amp #4 Output (Y_2)	22	W-BL
	V	P8-V		± Gnd (B)	18	BK
	V	P11-M		± Gnd (B)	18	BK
	X	P7-B		X_2 Input (#2)	Coax	
	Y	P7-A		Y_2 Input (#2)	Coax	
	Z	P7-C		Y_1 Input (#2)	Coax	

NOTES:
See Sheet 1

MILGO ELECTRONIC CORPORATION
MIAMI 47, FLORIDA

WIRE LIST | A 1576WL2A | SHEET 8 OF 23 SHEETS | C

DRAWN	DATE APPROVED FOR MFG. 5-27-60	C RO'm	P9 SCALE FACTOR AND PX MS3106B28-15SX W/MS3057-16(3032-86B P2)
CHECKED			
REVIEWED	REVISIONS		

WIRE NO.	TERMINAL	DESTINATION	CABLE	IDENTIFICATION	WIRE SIZE	COLOR
	a	P7-D		X_1 Input (#2)	Coax	
	e	P8-e		Chassis Ground	18	BK
	e	P11-K		Chassis Ground	18	BK
	g	P1-z		HQ Ground	18	BK
	h	P1-z		HQ Ground	18	BK
	l	P12-l		Amp #4 Grid	Coax	

NOTES:
See Sheet 1

MILGO ELECTRONIC CORPORATION
MIAMI 47, FLORIDA

WIRE LIST | A 1576WL2A SHEET 9 OF 23 SHEETS

DRAWN	DATE APPROVED FOR MFG. 5-27-60	C RO'm	MAIN CONTROL PANEL P10 CONNECTOR MS3106B36-10S (DAP) W/MS3057-24(3033-86A P2)
CHECKED			
REVIEWED	REVISIONS		

WIRE NO.	TERMINAL	DESTINATION	CABLE	IDENTIFICATION	WIRE SIZE	COLOR
	A	P1-A		$\emptyset_1$ In Fused	16	W-S
	B	P1-B		$\emptyset_2$ In Fused	16	S
	C	P1-C		60 cps AC Com.	18	W
	D	P1-D		$\emptyset_1$ Switched	16	W-S
	E	P1-E		$\emptyset_2$ Switched	16	S
	F	P1-F		Vacuum Pump Control	20	W-S
	G	P7-U		Timing Common	20	BK
	H	P9-J		Relay Ground	20	BK
	H	P12-U		Relay Ground	20	BK
	J	P1-n		Relay Voltage	20	O
	J	P12-T		Relay Voltage	22	O
	K	P1-p		Int. Relay Control	20	O
	L	P1-H		Light Control	20	W-S
	Q	P1-x		± Gnd (A)	18	BK
	R	P7-T		Arm 2 Lower Pen (Timing Input)	Coax	
	T	P1-R		Arm 1 Upper Pen Control	Coax	
	T	P7-e		Arm 1 Upper Pen Control	Coax	
	U	P1-L		Arm 1 Upper Pen (Auto Pen Lift Voltage)	Coax	
	V	P7-S		Arm 2 Upper Pen Timing Input	Coax	
	W	P7-R		Arm 1 Lower Pen Timing Input	Coax	

NOTES:
See Sheet 1

MILGO ELECTRONIC CORPORATION
MIAMI 47, FLORIDA

WIRE LIST | A 1576WL2A SHEET 10 OF 23 SHEETS

DRAWN | CHECKED | REVIEWED

DATE APPROVED FOR MFG. 5-27-60 RDM

REVISIONS

MAIN CONTROL PANEL P10
CONNECTOR
MS3106B36-10S (DAP)
W/MS3057-24(3033-86A P2)

WIRE NO.	TERMINAL	DESTINATION	CABLE	IDENTIFICATION	WIRE SIZE	COLOR
	Y	P7-P		Arm 1 Upper Pen Timing Input	Coax	
	a	P1-d		Arm 2 Lower Pen Control	Coax	
	a	P7-h		Arm 2 Lower Pen Control	Coax	
	b	P1-Z		Arm 2 Lower Pen (Auto Pen Lift Voltage)	Coax	
	c	P1-I		Arm 1 Lower Pen Control	Coax	
	c	P7-f		Arm 1 Lower Pen Control	Coax	
	d	P1-N		X_1 Servo Input	Coax	
	e	P1-m		X_2 Servo Input	Coax	
	f	P9-S		Amp #3 Output (X_2)	22	W-G
	f	P1-J		X_1 Interchange Input	Coax	
	g	P8-P		Amp #1 Output (X_1)	22	W-O
	g	P1-V		X_2 Interchange Input	Coax	
	h	P1-G		Arm 1 Lower Pen (Auto Pen Lift Voltage)	Coax	
	j	P1-j		Arm 2 Upper Pen Control	Coax	
	j	P7-g		Arm 2 Upper Pen Control	Coax	
	k	P1-h		Arm 2 Upper Pen (Auto Pen Lift Voltage)	Coax	
	m	P8-c		- Ref	18	W-V
	m	P12-e		- Ref	20	W-V
	p	P8-R		Amp #2 Output (Y_1)	22	W-Y

NOTES:
See Sheet 1

MILGO ELECTRONIC CORPORATION
MIAMI 47, FLORIDA

WIRE LIST | A 1576WL2A | SHEET 11 OF 23 SHEETS

DRAWN | CHECKED | REVIEWED

DATE APPROVED FOR MFG. 5-27-60 RDM

REVISIONS

MAIN CONTROL PANEL P10
CONNECTOR
MS3106B36-10S (DAP)
W/MS3057-24(3033-86A P2)

WIRE NO.	TERMINAL	DESTINATION	CABLE	IDENTIFICATION	WIRE SIZE	COLOR
	q	P9-T		Amp #4 Output (Y_2)	22	W-BL
	s	P7-W		Pen Control Signal Voltage	22	W-BL
	t	P8-b		+ Ref	18	W-R
	t	P12-d		+ Ref	20	W-R
	u	P1-b		Y_2 Servo Input	Coax	
	w	P1-c		Y_1 Servo Input	Coax	
	y	P1-y		HQ Ground	16	BK

NOTES:
See Sheet 1

MILGO ELECTRONIC CORPORATION
MIAMI 47, FLORIDA

WIRE LIST | A 1576WL2A | SHEET 12 OF 23 SHEETS

DRAWN	DATE APPROVED FOR MFG. 5/27/60	C	AUXILIARY CONTROL P11 PANEL CONNECTOR MS3106B28-12S (DAP) W/MS3057-16(3033-8A P1)
CHECKED			
REVIEWED	REVISIONS		

WIRE NO.	TERMINAL	DESTINATION	CABLE	IDENTIFICATION	WIRE SIZE	COLOR
	A	P9-F		Fil CT (Ground)	18	BK
	B	P9-B		Fil (Ground)	16	W-BR
	C	P9-G		Fil (Ground)	16	BR
	D	P9-D		Chopper Drive (Hot)	22	S
	E	P9-E		Chopper Drive (Gnd)	22	BK
	F	P7-V		Pen Control Signal Voltage	22	W-R
	G	P1-y		HQ Ground	18	BK
	H	P1-y		HQ Ground	18	BK
	H	P12-W		HQ Ground	20	BK
	J	P1-r		Ref Input	18	G
	K	P9-e		Chassis Ground	18	BK
	K	P12-X		Chassis Ground	18	BK
	L	P7-d		Remote Relay Voltage	20	O
	M	P9-V		± Ground (B)	18	BK
	M	P12-V		± Ground (B)	18	BK
	P	P9-C		Fil (-300V)	16	W-BR
	R	P9-A		Fil (-300V)	16	BR
	S	P8-W		-300V Reg	22	W
	T	P8-M		-400V	22	S
	V	P8-H		#1 Relay Control	20	O
	V	P7-a		#1 Relay Control	20	O
	W	P9-H		#2 Relay Control	20	O
	W	P7-b		#2 Relay Control	20	O

NOTES:
See Sheet 1

MILGO ELECTRONIC CORPORATION
MIAMI 47, FLORIDA

WIRE LIST | A 1576WL2A SHEET 13 OF 23 SHEETS

DRAWN	DATE APPROVED FOR MFG. 5/27/60	C	AUXILIARY CONTROL P11 PANEL CONNECTOR MS3106B28-12S (DAP) W/MS3057-16(3033-8A P1)
CHECKED			
REVIEWED	REVISIONS G		

WIRE NO.	TERMINAL	DESTINATION	CABLE	IDENTIFICATION	WIRE SIZE	COLOR
	X	P7-c		#3 Relay Control	20	O
	Z	P8-U		+300V Reg	22	R
	Z	P12-A		+300V Reg	22	R
	a	P7-p		#1 Arm Standby	20	BL
	b	P7-r		#2 Arm Standby	20	GR
	d	P1-k		-450 V Unregulated	22	S
	d	P12-C		-450V Unregulated	20	S

NOTES:
See Sheet 1

MILGO ELECTRONIC CORPORATION
MIAMI 47, FLORIDA

WIRE LIST | A 1576WL2A SHEET 14 OF 23 SHEETS

DRAWN	DATE APPROVED FOR MFG. 5-2-45	C
CHECKED		
REVIEWED	REVISIONS 6	

AUXILIARY CONTROL P12
MS3106B-28-15SY (DAP)
W/MS3057-16

WIRE NO.	TERMINAL	DESTINATION	CABLE	IDENTIFICATION	WIRE SIZE	COLOR
	A	P11-Z		+300V Reg	22	R
	C	P11-d		-450V	20	S
	F	P7-j		Pen Select Arm #1	20	GR
	G	P7-k		Pen Select Arm #2	20	GR
	P	P7-m		E.O.P.	20	BL
	R	P7-n		Standby Voltage	20	BL
	T	P10-J		+28V	22	O
	U	P10-H		Relay Gnd	20	BK
	V	P7-s		± Gnd	18	BK
	V	P11-M		± Gnd	18	BK
	W	P11-H		HQ Gnd	20	BK
	X	P11-K		Chassis Ground	18	BK
	d	P10-t		+ Ref	20	W-R
	e	P10-m		- Ref	20	W-V
	l	P9-1		Amp #4 Grid	Coax	
	m	P8-d		Amp #2 Grid	Coax	

NOTES:
See Sheet 1

MILGO ELECTRONIC CORPORATION
MIAMI 47, FLORIDA

WIRE LIST A 1576WL2A SHEET 15 OF 23 SHEETS

DRAWN	DATE APPROVED FOR MFG. 5/27/45	C
CHECKED		
REVIEWED	REVISIONS	

AUXILIARY CONTROL P13
MS3106B-18-4S

WIRE NO.	TERMINAL	DESTINATION	CABLE	IDENTIFICATION	WIRE SIZE	COLOR
	A	TB1-13		X_1 Servo (Hot)	22	S
	B	TB1-9		Y_1 Servo (Hot)	22	S
	C	TB4-13		X_2 Servo (Hot)	22	S
	D	TB4-9		Y_2 Servo (Hot)	22	S

NOTES:
See Sheet 1

MILGO ELECTRONIC CORPORATION
MIAMI 47, FLORIDA

WIRE LIST A 1576WL2A SHEET 16 OF 23 SHEETS

DRAWN	DATE APPROVED FOR MFG. 5/27/	JUMPER CONNECTIONS
CHECKED		
REVIEWED	REVISIONS	

WIRE NO.	TERMINAL	DESTINATION	CABLE	IDENTIFICATION	WIRE SIZE	COLOR
	P1-y P1-z				16	BUS

NOTES:
See Sheet 1

MILGO ELECTRONIC CORPORATION
MIAMI 47, FLORIDA

WIRE LIST | A1576WL2A SHEET 17 OF 23 SHEETS

DRAWN	DATE APPROVED FOR MFG.	J6
CHECKED		AUXILIARY SIGNAL CONNECTOR MS3102A-28-15P (DAP)
REVIEWED	REVISIONS 1	

WIRE NO.	TERMINAL	DESTINATION	CABLE	IDENTIFICATION	WIRE SIZE	COLOR
	A	J7-A		Y_2 Input (#2)	Coax	
	B	J7-B		X_2 Input (#2)	Coax	
	C	J7-C		Y_1 Input (#2)	Coax	
	D	J7-D		X_1 Input (#2)	Coax	
	P	J7-P		Timing Input Arm 1 Upper Pen	Coax	
	R	J7-R		Timing Input Arm 1 Lower Pen	Coax	
	S	J7-S		Timing Input Arm 2 Upper Pen	Coax	
	T	J7-T		Timing Input Arm 2 Lower Pen	Coax	
	U	J7-U		Timing Common	20	BK
	V	J7-V		Pen Control Signal Voltage	22	W-R
	W	J7-W		Pen Control Signal Voltage	22	W-BL
	X	J7-r		#2 Arm Standby	20	GR
	Y	J7-s		± Gnd	18	BK
	Z	J7-p		#1 Arm Standby	20	BL
	a	J7-a		Relay #1 Control	20	O
	b	J7-b		Relay #2 Control	20	O
	c	J7-c		Realy #3 Control	20	O
	d	J7-d		Remote Relay Voltage	20	O
	e	J7-e		Arm 1 Upper Pen Control	Coax	
	f	J7-f		Arm 1 Lower Pen Control	Coax	
	g	J7-g		Arm 2 Upper Pen Control	Coax	

NOTES:

MILGO ELECTRONIC CORPORATION
MIAMI 47, FLORIDA

WIRE LIST | A1576WL2A SHEET 18 OF 23 SHEETS

DRAWN | CHECKED | REVIEWED

DATE APPROVED FOR MFG. 5/27/60 C

REVISIONS C

J6

AUXILIARY SIGNAL CONNECTOR
MS3102A-28-15P (DAP)

WIRE NO.	TERMINAL	DESTINATION	CABLE	IDENTIFICATION	WIRE SIZE	COLOR
	h	J7-h		Arm 2 Lower Pen Control	Coax	
	j	J7-j		Pen Select Arm #1	20	GR
	k	J7-k		Pen Select Arm #2	20	GR
	l	J7-m		E.O.P.	20	BL
	m	J7-n		Standby Voltage	20	BL

NOTES:

MILGO ELECTRONIC CORPORATION
MIAMI 47, FLORIDA

WIRE LIST | A 1576WL2 A | SHEET 19 OF 23 SHEETS C

DRAWN | CHECKED | REVIEWED

DATE APPROVED FOR MFG. 5/27/60 C

REVISIONS

J7

AUXILIARY SIGNAL CONNECTOR
MS3102-28-21S (DAP)

WIRE NO.	TERMINAL	DESTINATION	CABLE	IDENTIFICATION	WIRE SIZE	COLOR
	A	J6-A		Y_2 Input (#2)	Coax	
	B	J6-B		X_2 Input (#2)	Coax	
	C	J6-C		Y_1 Input (#2)	Coax	
	D	J6-D		X_1 Input (#2)	Coax	
	P	J6-P		Timing Input Arm 1 Upper Pen	Coax	
	R	J6-R		Timing Input Arm 1 Lower Pen	Coax	
	S	J6-S		Timing Input Arm 2 Upper Pen	Coax	
	T	J6-T		Timing Input Arm 2 Lower Pen	Coax	
	U	J6-U		Timing Common	20	BK
	V	J6-V		Pen Control Signal Voltage	22	W-R
	W	J6-W		Pen Control Signal Voltage	22	W-BL
	a	J6-a		Relay #1 Control	20	O
	b	J6-b		Relay #2 Control	20	O
	c	J6-c		Relay #3 Control	20	O
	d	J6-d		Remote Relay Voltage	20	O
	e	J6-e		Arm 1 Upper Pen Control	Coax	
	f	J6-f		Arm 1 Lower Pen Control	Coax	
	g	J6-g		Arm 2 Upper Pen Control	Coax	
	h	J6-h		Arm 2 Lower Pen Control	Coax	

NOTES:

MILGO ELECTRONIC CORPORATION
MIAMI 47, FLORIDA

WIRE LIST | A1576WL2A | SHEET 20 OF 23 SHEETS C

DRAWN | DATE APPROVED FOR MFG. 5-27-71 | C

CHECKED

REVIEWED | REVISIONS (1) (2)

AUXILIARY SIGNAL CONNECTOR
MS3102-28-21S (DAP)

J7

WIRE NO.	TERMINAL	DESTINATION	CABLE	IDENTIFICATION	WIRE SIZE	COLOR
	j	J6-j		Pen Select Arm #1	20	GR
	k	J6-k		Pen Select Arm #2	20	GR
	m	J6-l		E.O.P.	20	BL
	n	J6-m		Standby Voltage	20	BL
	p	J6-Z		#1 Arm Standby	20	BL
	r	J6-X		#2 Arm Standby	20	GR
	s	J6-Y		± Gnd	18	BK

NOTES:

MILGO ELECTRONIC CORPORATION
MIAMI 47, FLORIDA

WIRE LIST | A1576WL2A SHEET 21 OF 23 SHEETS

DRAWN

CHECKED

REVIEWED | DATE APPROVED FOR MFG. | C | REVISIONS

TB1
X_1 AND Y_1 GEAR BOX TERMINATIONS

WIRE NO.	TERMINAL	DESTINATION	CABLE	IDENTIFICATION	WIRE SIZE	COLOR
	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9	P13-B		Y_1 Servo (Hot)	22	S
	10					
	11					
	12					
	13	P13-A		X_1 Servo (Hot)	22	S

NOTES: These connections are in addition to regular connections. Run separate from all other cables. Run direct. (See 15W1A)

MILGO ELECTRONIC CORPORATION
MIAMI 47, FLORIDA

WIRE LIST | A1576WL2A SHEET 22 OF 23 SHEETS

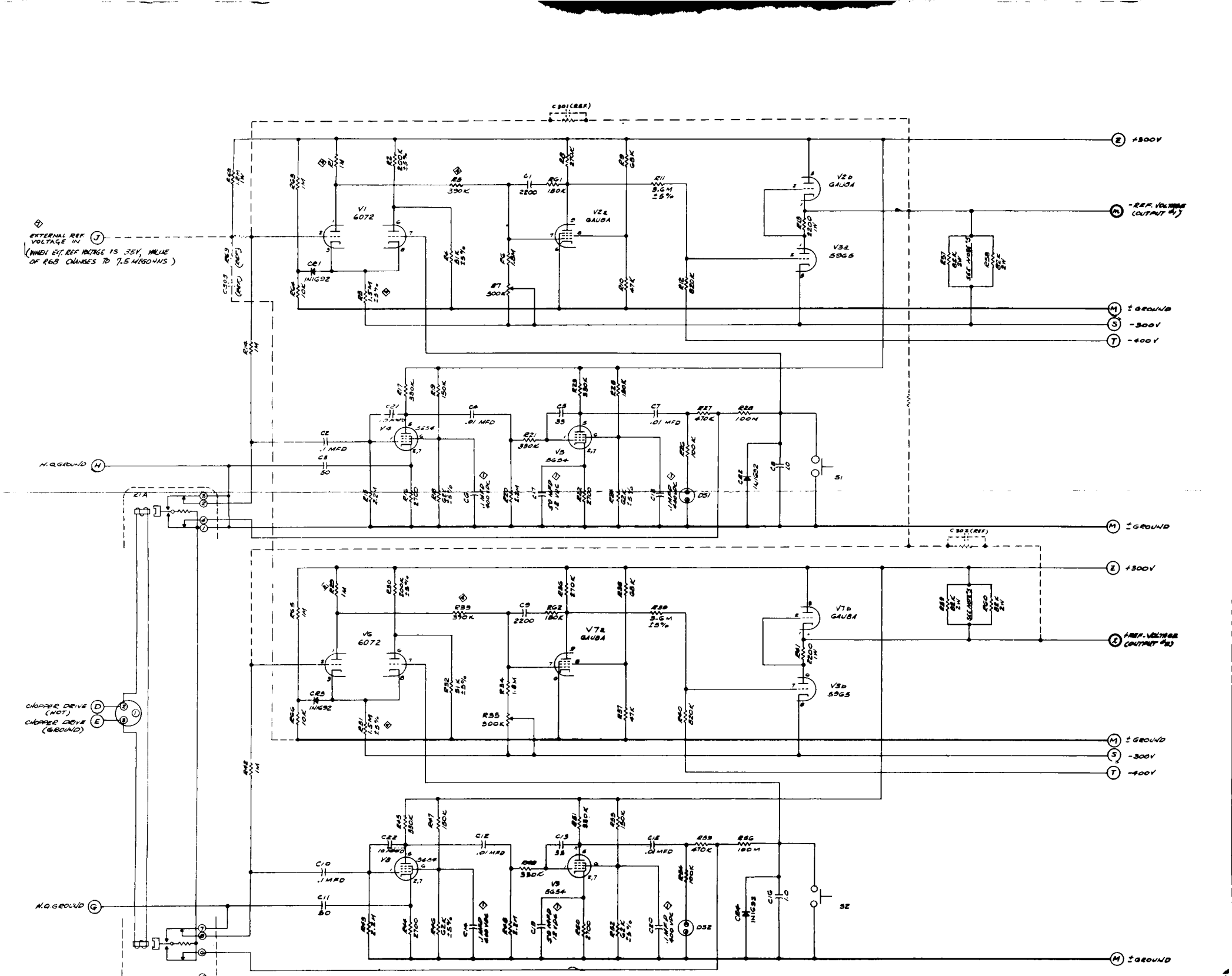
DRAWN	DATE APPROVED FOR MFG. 4-7-[illegible]		TB4
CHECKED			X_2 AND Y_2 GEAR BOX TERMINATIONS
REVIEWED	REVISIONS		

WIRE NO.	TERMINAL	DESTINATION	CABLE	IDENTIFICATION	WIRE SIZE	COLOR
	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9	P13-D		Y_2 Servo (Hot)	22	S
	10					
	11					
	12					
	13	P13-C		X_2 Servo (Hot)	22	S

NOTES:
See Sheet 22

MILGO ELECTRONIC CORPORATION
MIAMI 47, FLORIDA

WIRE LIST | A1576WL2A SHEET 23 OF 23 SHEETS


EXTERNAL REF. VOLTAGE IN
(WHEN EXT. REF VOLTAGE IS 35V, VALUE OF R68 CHANGES TO 7.5 MEGOHMS)
V1 6072
V2a 6AU8A
V2b 6AU8A
V3a 5965
V3b 5965
V4 5654
V5 5654
V6 6072
V7a 6AU8A
V7b 6AU8A
V8 5654
V9 5654
CR1 IN1692
CR2 IN1692
CR3 IN1692
CR4 IN1692
D51
D52
S1
S2
+300V
-REF. VOLTAGE (OUTPUT "A")
±GROUND
-300V
-400V
H.Q. GROUND
CHOPPER DRIVE (HOT)
CHOPPER DRIVE (GROUND)
SELECTED
C301 (REF)
C302 (REF)

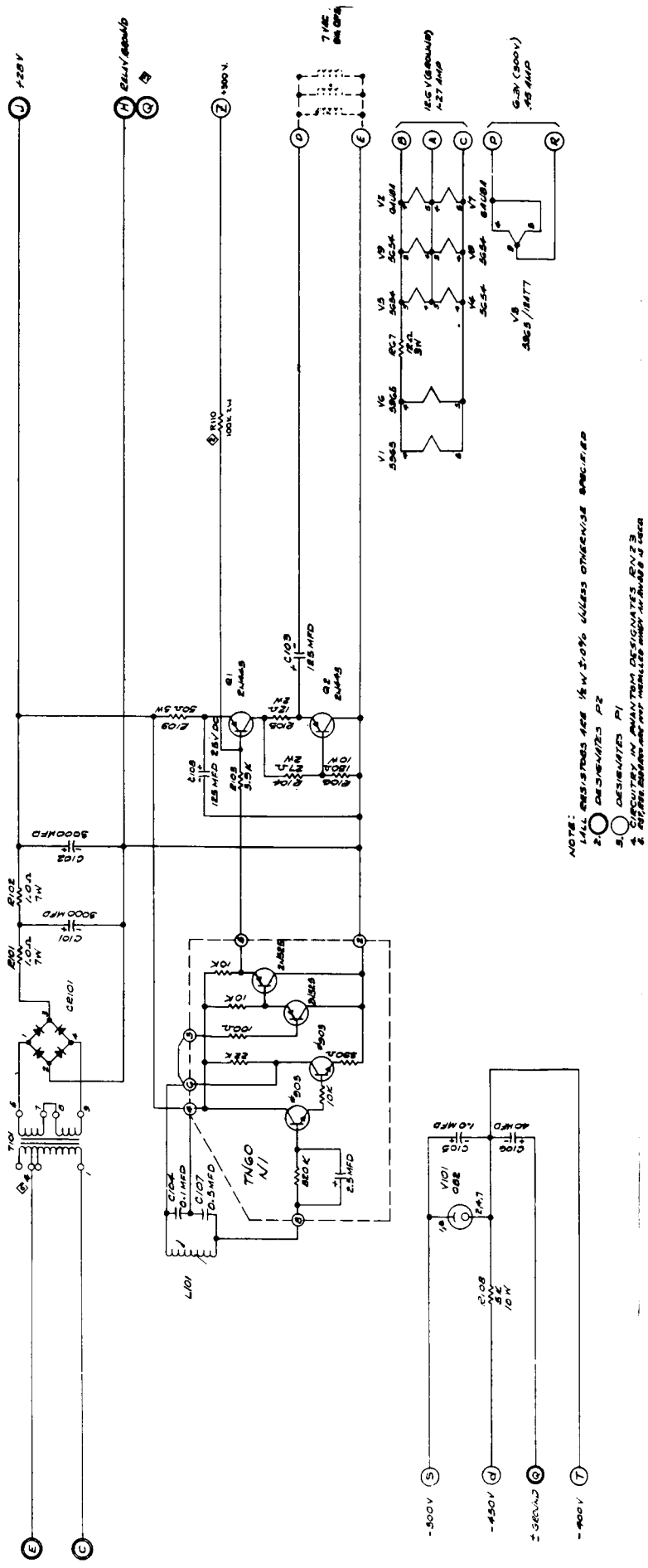
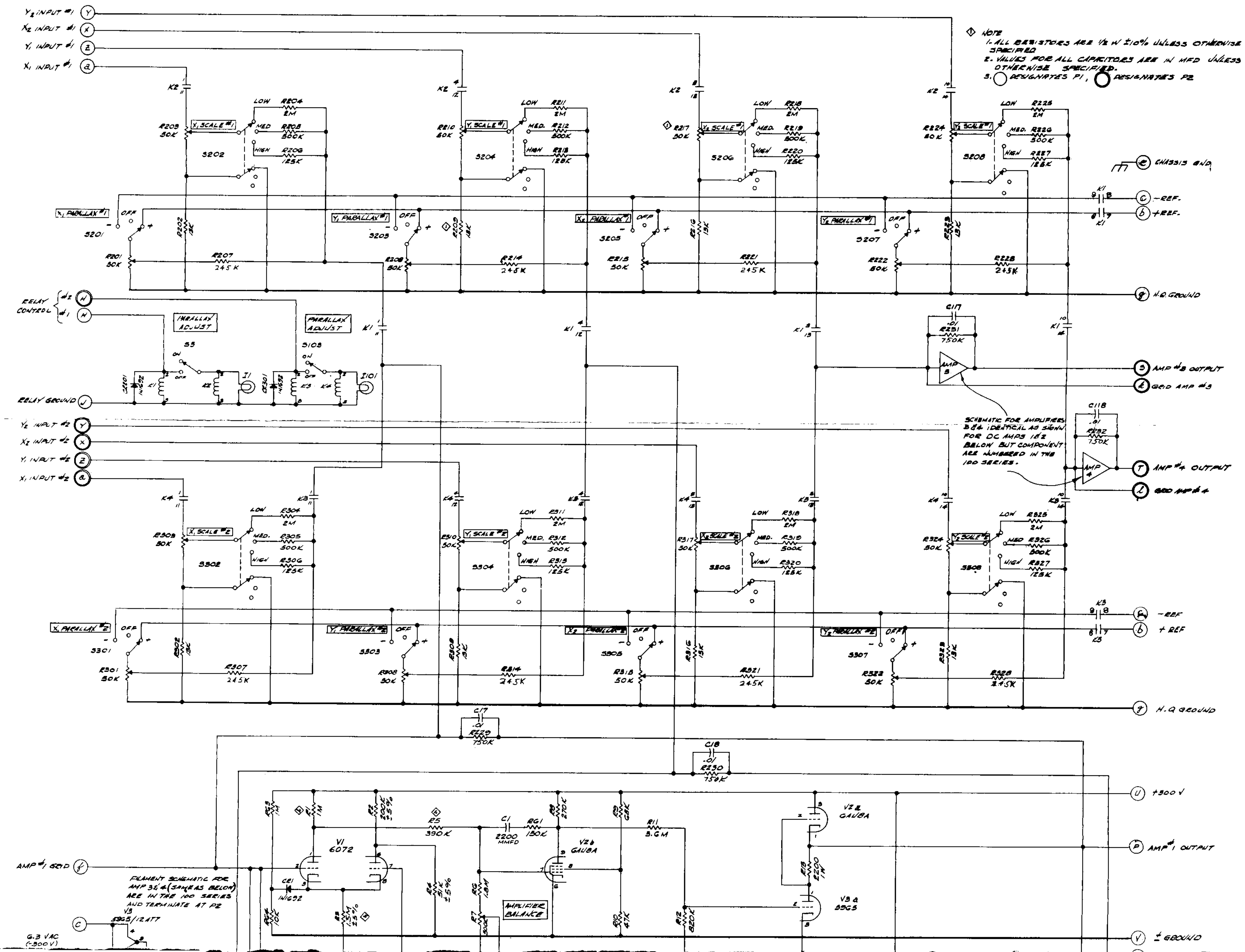


Figure 7-1. Control Unit, Dual D.C. Amplifier (Reference Supplies) Schematic (E3033S86A)


NOTE
1. ALL RESISTORS ARE 1/2 W ±10% UNLESS OTHERWISE SPECIFIED
2. VALUES FOR ALL CAPACITORS ARE IN MFD UNLESS OTHERWISE SPECIFIED.
3. ○ DESIGNATES P1, ○ DESIGNATES P2
Y2 INPUT #1
X2 INPUT #1
Y1 INPUT #1
X1 INPUT #1
X1 SCALE #1
Y1 SCALE #1
X2 SCALE #1
Y2 SCALE #1
X1 PARALLAX #1
Y1 PARALLAX #1
X2 PARALLAX #1
Y2 PARALLAX #1
CHASSIS GND
-REF.
+REF.
H.Q. GROUND
RELAY CONTROL
RELAY GROUND
PARALLAX ADJUST
AMP #3 OUTPUT
GRID AMP #3
AMP #4 OUTPUT
GRID AMP #4
SCHEMATIC FOR AMPLIFIERS 3 & 4 IDENTICAL AS SHOWN FOR DC AMPS 1 & 2 BELOW BUT COMPONENT ARE NUMBERED IN THE 100 SERIES.
Y2 INPUT #2
X2 INPUT #2
Y1 INPUT #2
X1 INPUT #2
X1 SCALE #2
Y1 SCALE #2
X2 SCALE #2
Y2 SCALE #2
X1 PARALLAX #2
Y1 PARALLAX #2
X2 PARALLAX #2
Y2 PARALLAX #2
- REF
+ REF
H.Q. GROUND
+300 V
AMP #1 OUTPUT
± GROUND
AMP #1 GRID
FILAMENT SCHEMATIC FOR AMP 3 & 4 (SAME AS BELOW) ARE IN THE 100 SERIES AND TERMINATE AT P2
6.3 VAC (-300 V)
AMPLIFIER BALANCE
V1 6072
V2b 6AU6A
V2a 6AU6A
V3a 5965
V3 5965/12AT7

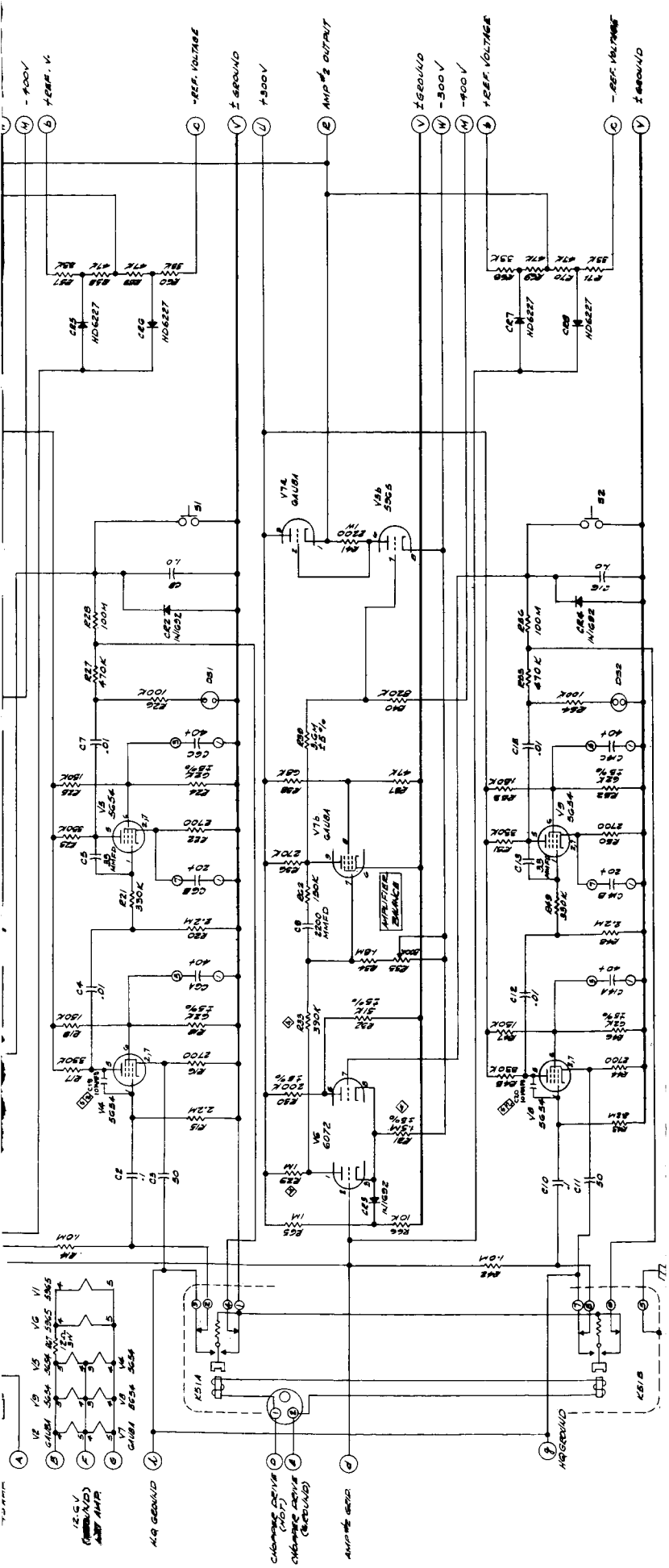
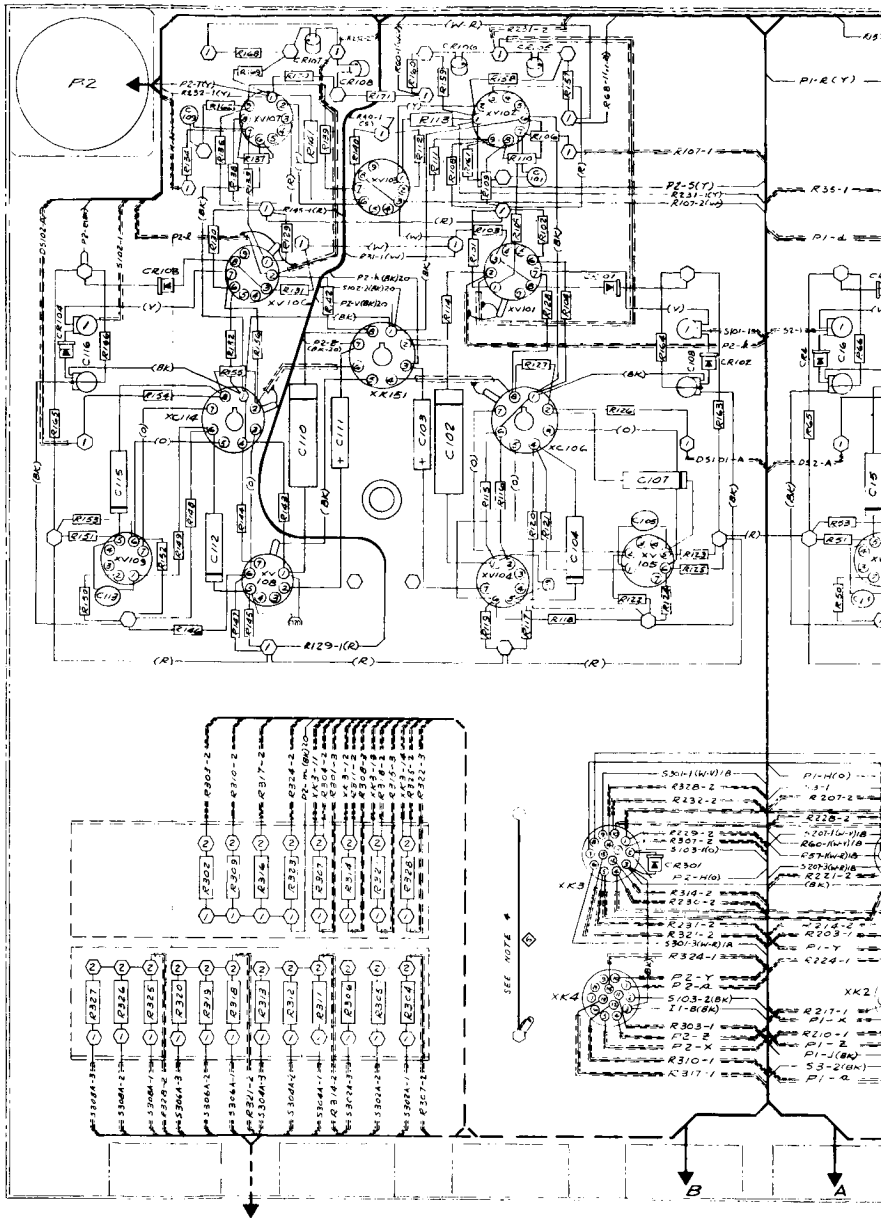
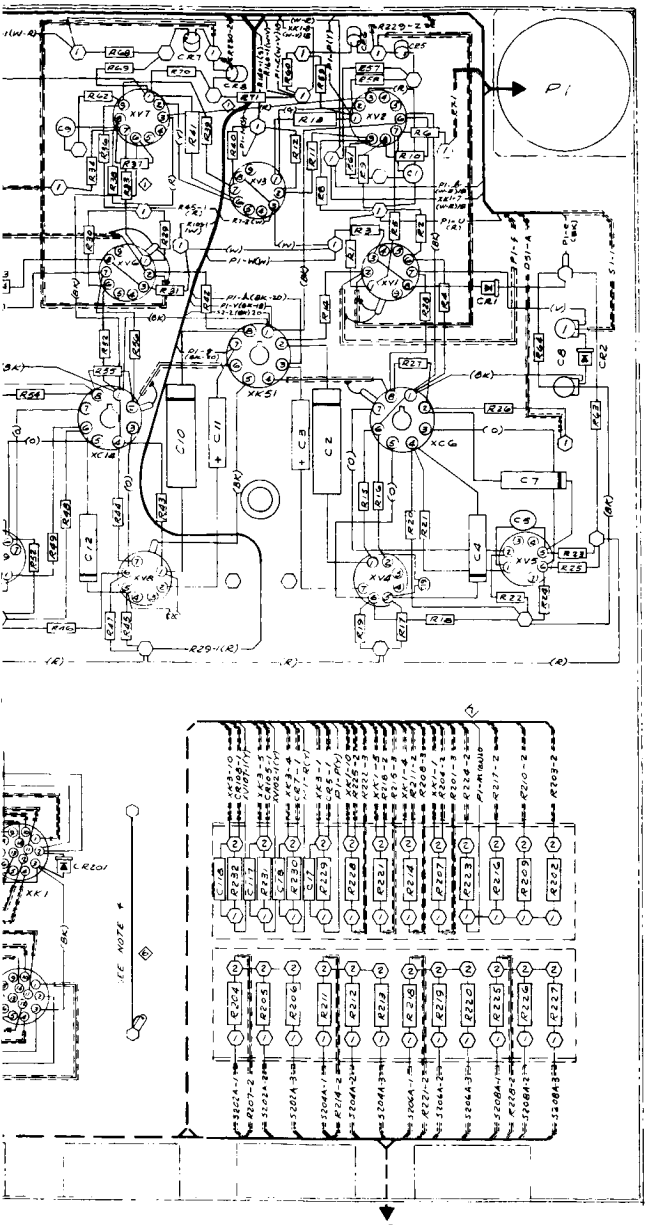


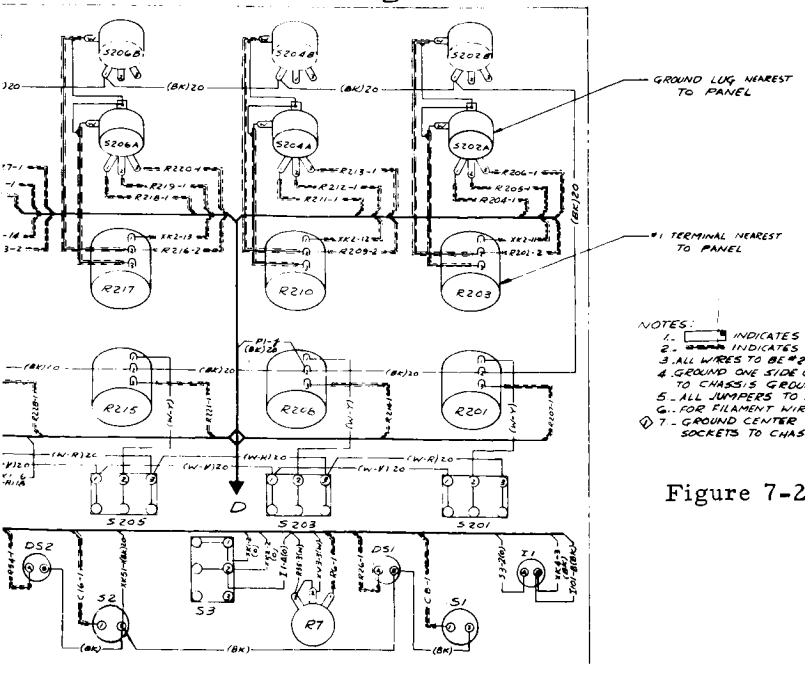
Figure 7-2. Scale Factor and Parallax Unit Schematic (E3032S86B)

P2			
TERMINAL	DESTINATION	WIRE SIZE & COLOR	IDENTIFICATION
A	XV103-9	20/BR	FIL 2(-300V)
B	XV102-4	20/W-BR	FIL 3(GND)
C	XV103-5	20/W-BR	FIL 2(-300V)
D	CHOPPER CAP TERM #1	20/S	CHOPPER DR(HOT)
E	CHOPPER CAP TERM #2	20/BK	CHOPPER DR(GND)
F	XV107-4	20/BK	FIL 3 C.T.(GND)
G	XV107-5	20/BR	FIL-3 (GND)
H	XK3-2	O	RELAY #2 CONTROL
S	XV102-1	Y	AMP #3 OUTPUT
T	XV107-1	Y	AMP #4 OUTPUT
V	XK151-1	20/BK	I GROUND
X	XK4-5		X_2 INPUT #2
Y	XK4-10		Y_2 INPUT #2
Z	XK4-4		Y_1 INPUT #2
a	XK4-1		X_1 INPUT #2
e	GND LUG	BK	CHASSIS GND
g	XK151-7	20/BK	HQ GND
k	XK151-3	20/BK	HQ GND
k	XV101-2		AMP #3 GRID
k	R308-2	20/BK	HQ GND
l	XV106-2		AMP #4 GRID
m	R323-1	20/BK	HQ GND
JUMPER g, k, & m TOGETHER			





P1			
TERMINAL	DESTINATION	WIRE SIZE & COLOR	IDENTIFICATION
A	XV3-9	20/BR	FIL 2 (-300 V)
B	XV2-4	20/W-BR	FIL 3 (GND)
C	XV3-5	20/W-BR	FIL 2 (-300 V)
D	CHOPPER DRIVE CAP TERMINAL	20/S	CHOPPER DR. (HOT)
E	CHOPPER DRIVE CAP TERMINAL	20/BK	CHOPPER DR GND
F	XV2-5	20/BK	FIL 3 CT (GND)
G	XV1-5	20/BR	FIL 3 (GND)
H	XK1-2	0	RELAY #1 CONTROL
J	XK2-3	BK	RELAY CONTROL GND
M	R12-1	S	- 600V
P	R229-1	Y	AMP #1 OUTPUT
P	XV2-1	Y	AMP #1 OUTPUT
R	R230-1	Y	AMP #2 OUTPUT
R	XV7-1	Y	AMP #2 OUTPUT
U	R1-1	R	+ 300V
V	XK51-1	20/BK	⏚ GND
W	R3-1	W	- 300V
X	XK2-5		X_2 INPUT #1
Y	XK2-10		Y_2 INPUT #1
Z	XK2-4		Y_1 INPUT #1
a	XK2-1		X_1 INPUT #1
b	R57-1	18/W-R	+ REF
c	RG0-1	18/W-V	- REF
d	XV6-2		AMP #2 GRID
e	GND LUG	BK	CHASSIS GND
f	XV1-2		AMP #1 GRID
g	XK51-7	20/BK	HQ GND
h	XK51-3	20/BK	HQ GND
j	R208-2	20/BK	HQ GND
m	R223-1	20/BK	HQ GND
JUMPER g, h, j & m TOGETHER			

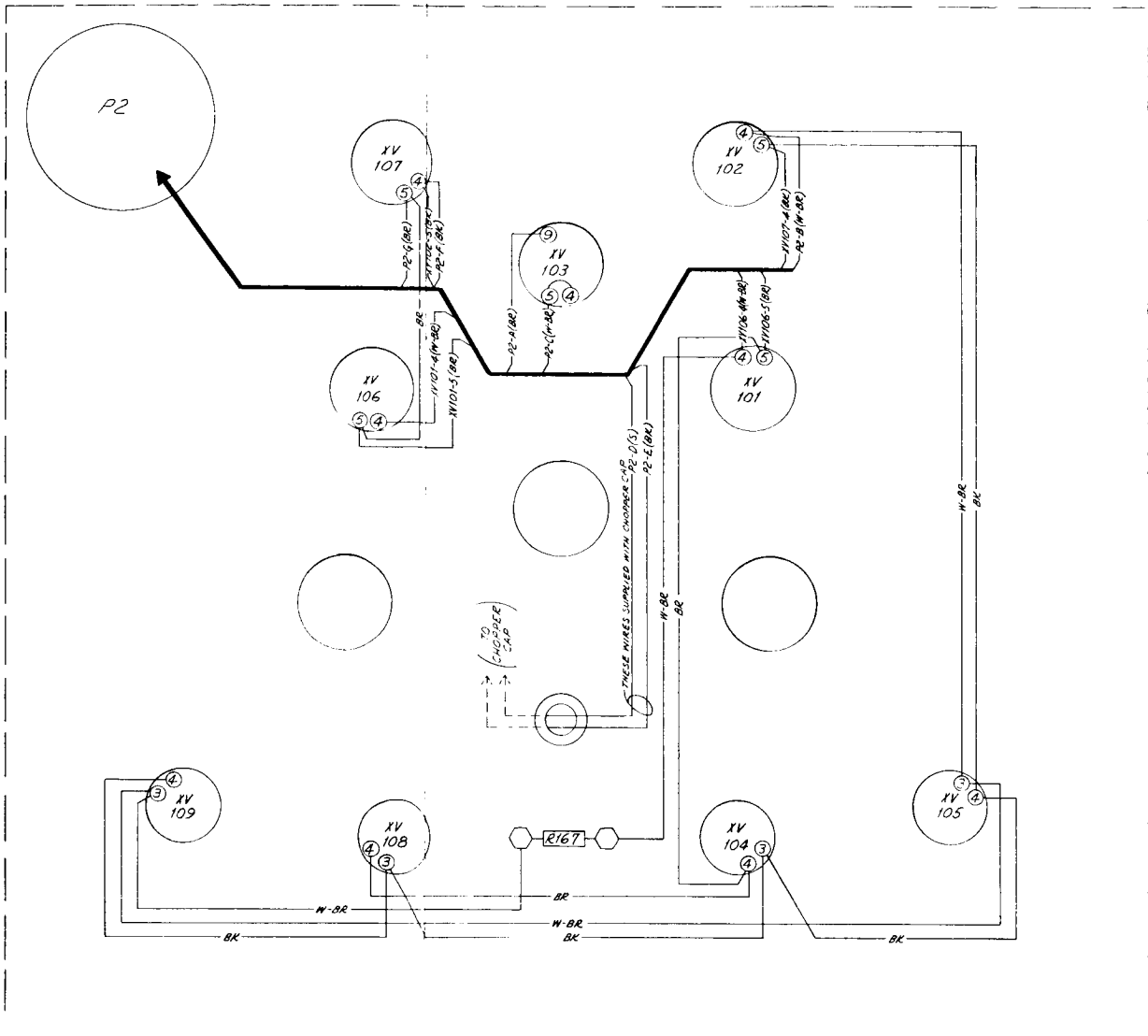


NOTES:
1. ▭ INDICATES LEADS TO DC AMPLIFIER.
2. ▬▬ INDICATES COAX RG 174/U.
3. ALL WIRES TO BE #22 GAGE UNLESS OTHERWISE NOTED.
4. GROUND ONE SIDE ONLY OF EACH COAX SHIELD TO CHASSIS GROUND.
5. ALL JUMPERS TO BE #20 BUS.
6. FOR FILAMENT WIRING SEE DWG. D3032W86B
7. GROUND CENTER POSTS OF MINIATURE TUBE SOCKETS TO CHASSIS GROUND.

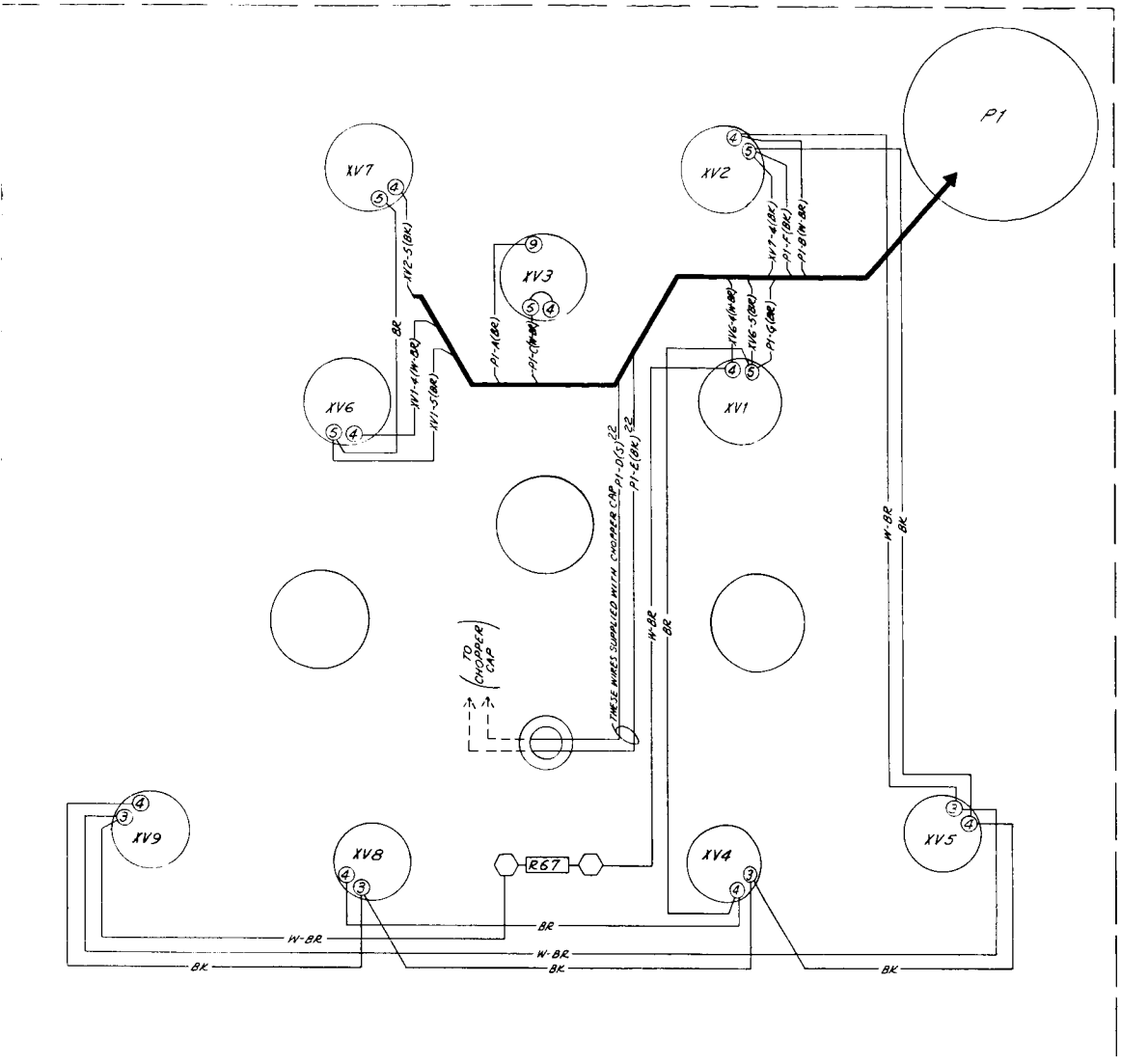
Figure 7-2a. Wiring Diagram

Scale Factor and Parallax Unit

Dwg. #3032W86B, Sheet #1



P1			
PIN #	DESTINATION	WIRE SIZE & COLOR	INDENTIFICATION
A	XV3-9	BR	FIL 2 (-300V)
B	XV2-4	W-BR	FIL 3 (GND)
C	XV3-5	W-BR	FIL 2 (-300V)
D	CHOPPER CAP TERM. #1	S	CHOPPER DRIVE
E	CHOPPER CAP TERM. #2	BK	CHOPPER DRIVE
F	XV2-5	BK	FIL 3 C.T. (GND)
G	XV1-5	BR	FIL 3 (GND)
P2			
A	XV103-9	BR	FIL 2 (-300V)
B	XV102-4	W-BR	FIL 3 (GND)
C	XV103-5	W-BR	FIL 2 (-300V)
D	CHOPPER CAP TERM. #1	S	CHOPPER DRIVE
E	CHOPPER CAP TERM. #2	BK	CHOPPER DRIVE
F	XV107-4	BK	FIL 3 C.T. (GND)
G	XV107-5	BR	FIL 3 (GND)

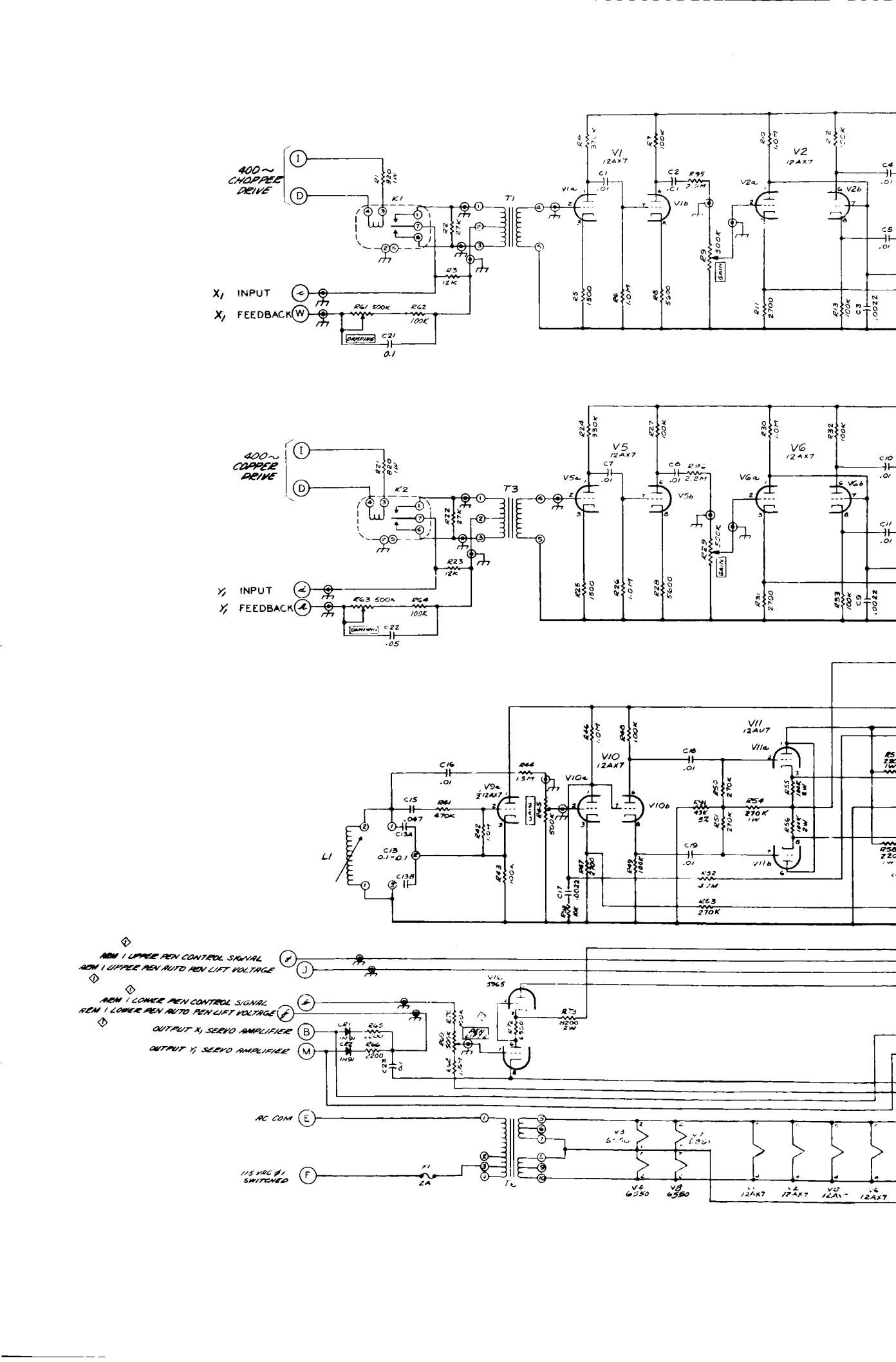


NOTES:
1. TWIST ALL ADJACENT WIRES.
2. ALL WIRES TO BE #20 GA., UNLESS OTHERWISE SPECIFIED.

Figure 7-2b. Wiring Diagram

Scale Factor and Parallax Unit

Dwg. #3032W86B, Sheet #2


400~ CHOPPER DRIVE
X, INPUT
X, FEEDBACK
DAMPING
400~ COPPER DRIVE
Y, INPUT
Y, FEEDBACK
DAMPING
V1 12AX7
V2 12AX7
V5 12AX7
V6 12AX7
V10 12AX7
V11 12AU7
T1
T3
K1
K2
L1
GAIN
REM 1 UPPER PEN CONTROL SIGNAL
REM 1 UPPER PEN AUTO PEN LIFT VOLTAGE
REM 1 LOWER PEN CONTROL SIGNAL
REM 1 LOWER PEN AUTO PEN LIFT VOLTAGE
OUTPUT X, SERVO AMPLIFIER
OUTPUT Y, SERVO AMPLIFIER
AC COM
115 VAC Ø1 SWITCHED
F1
2A
V3
V4 6550
V8 6550
V1 12AX7
V2 12AX7
V5 12AX7
V6 12AX7

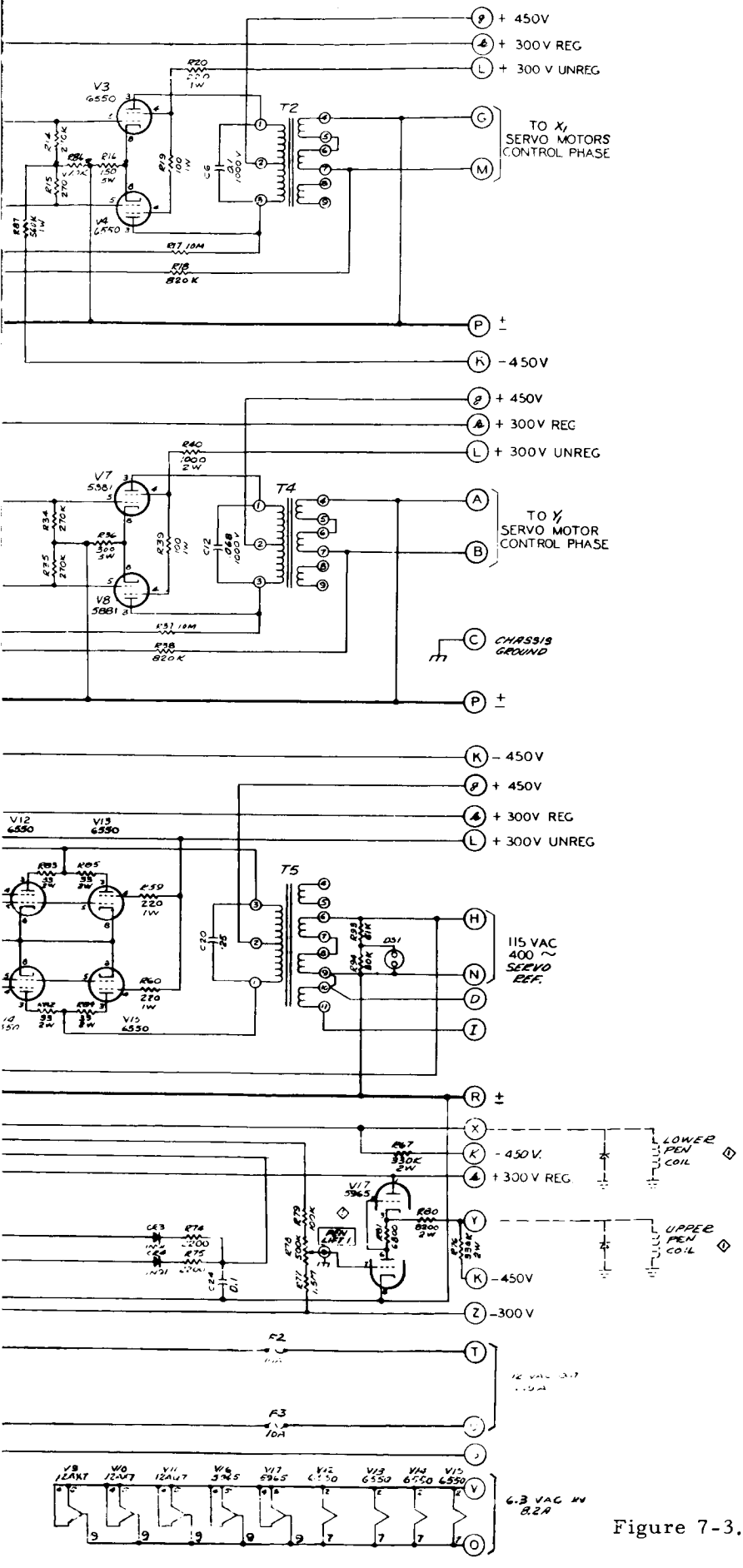
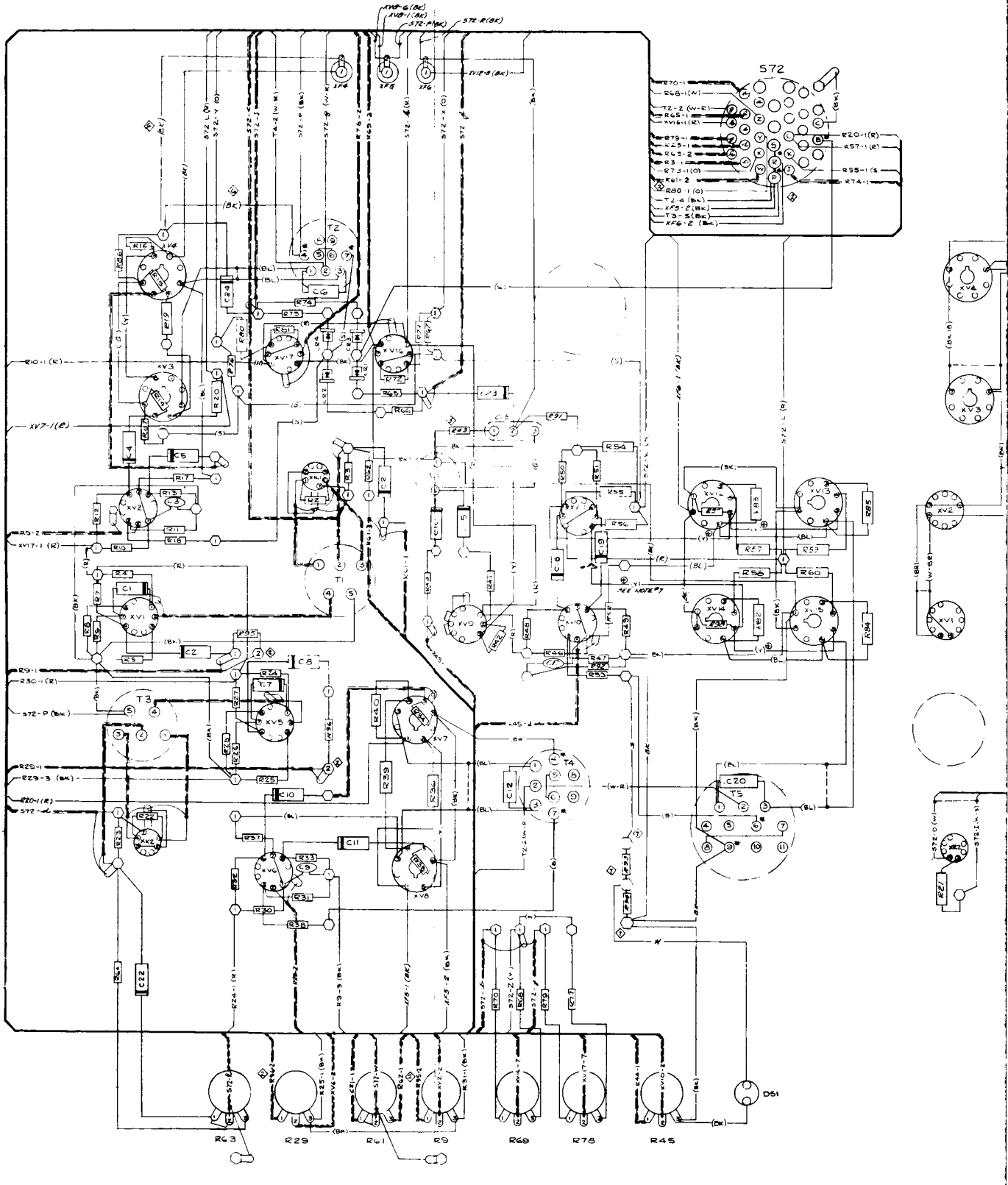
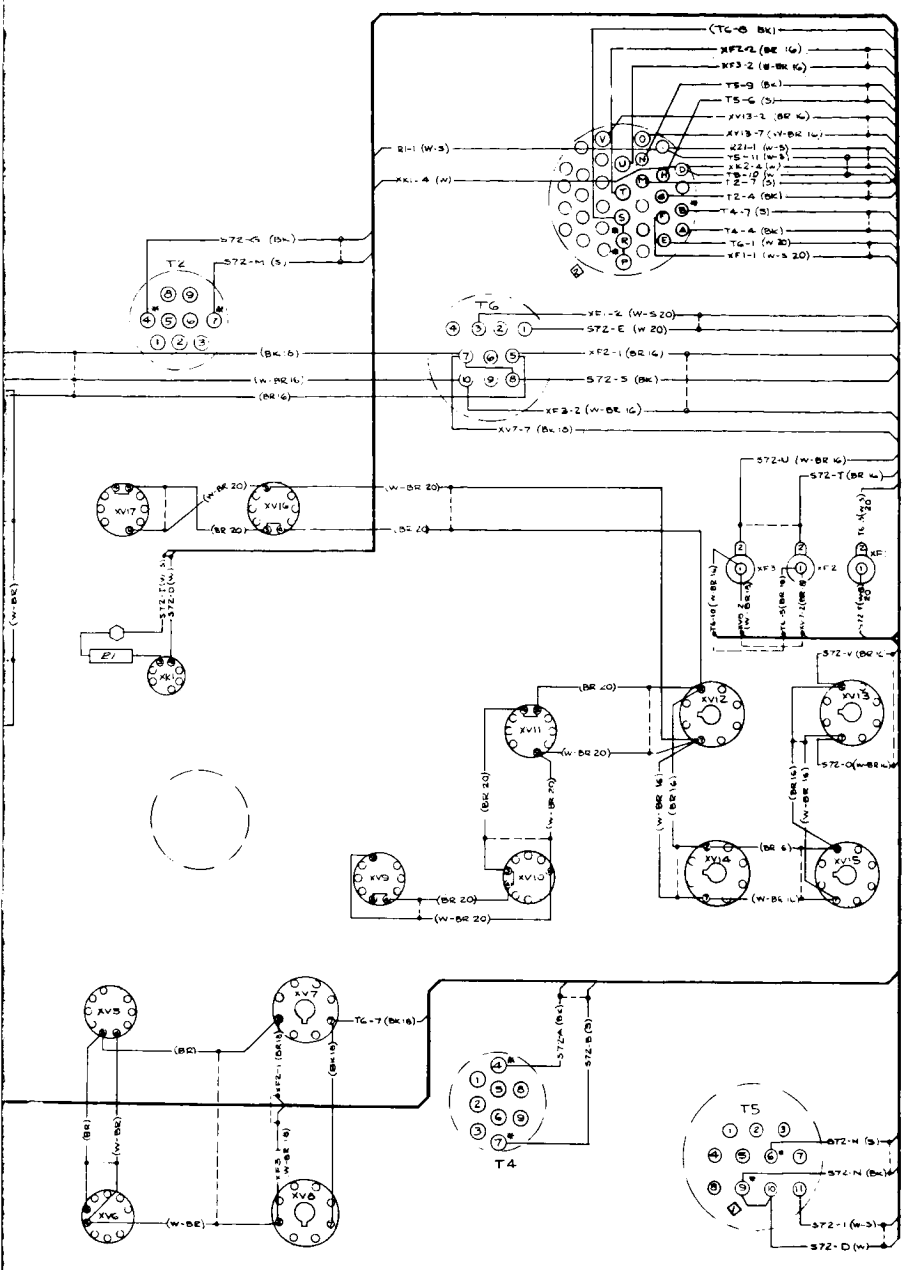


Figure 7-3. Schematic, Servo Supply


S72
T1
T2
T3
T4
T5
R63
R29
R61
R9
R69
R75
R45
D51

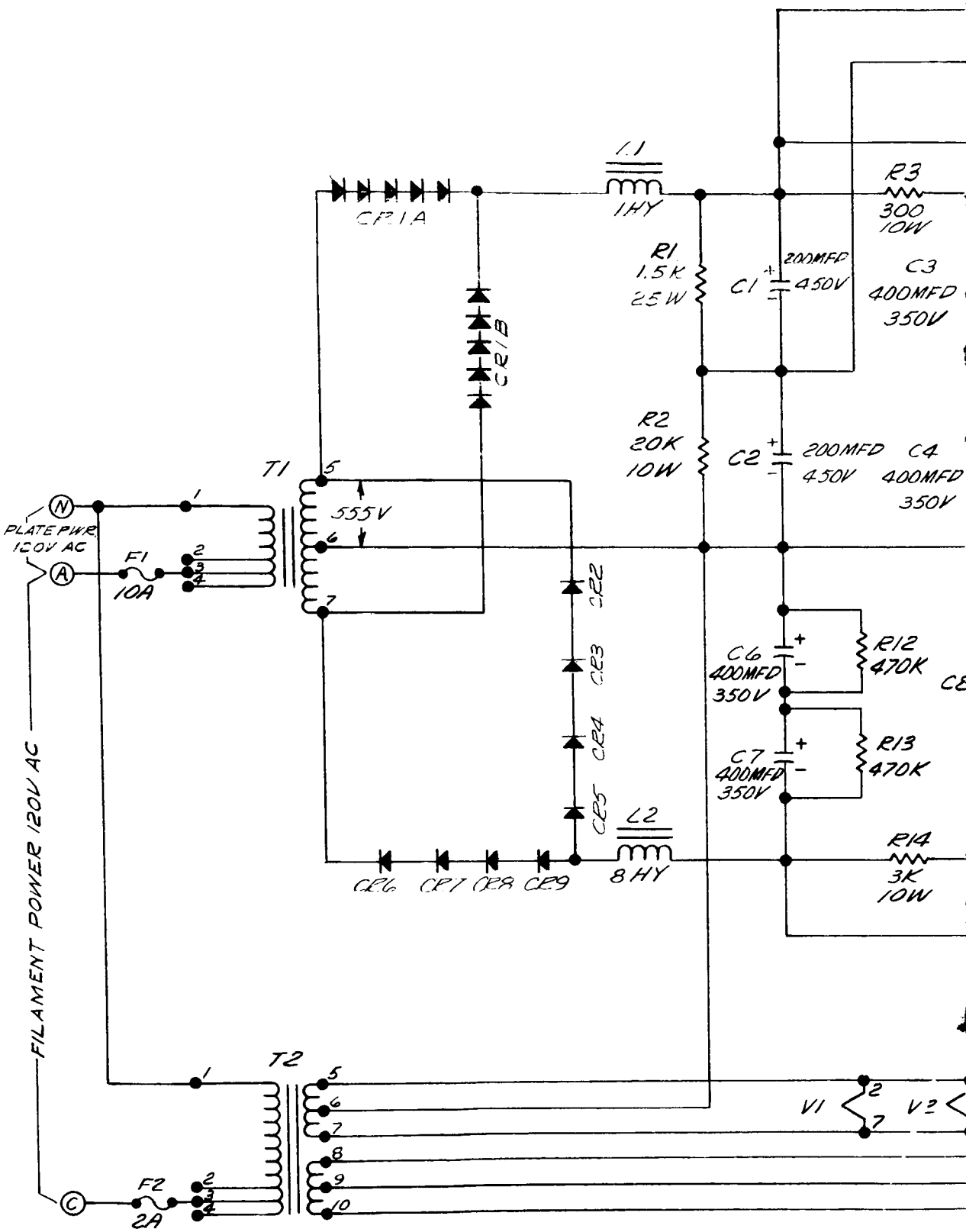


NOTES.
1. ALL JUMPERS TO BE #20 BUS.
2. ALL WIRES TO BE #22 UNLESS OTHERWISE SPECIFIED.
3. ▬▬ INDICATES COAX RG 174/U.
4. GROUND CENTRE POST ON ALL MINIATURE SOCKETS WITH LUG PROVIDED.
5. ▭ INDICATES OUTER FOIL.
6. * CONNECTIONS EXIST IN BOTH VIEWS.
7. ⊕ THESE LEADS TO BE KEPT AS SHORT AS POSSIBLE

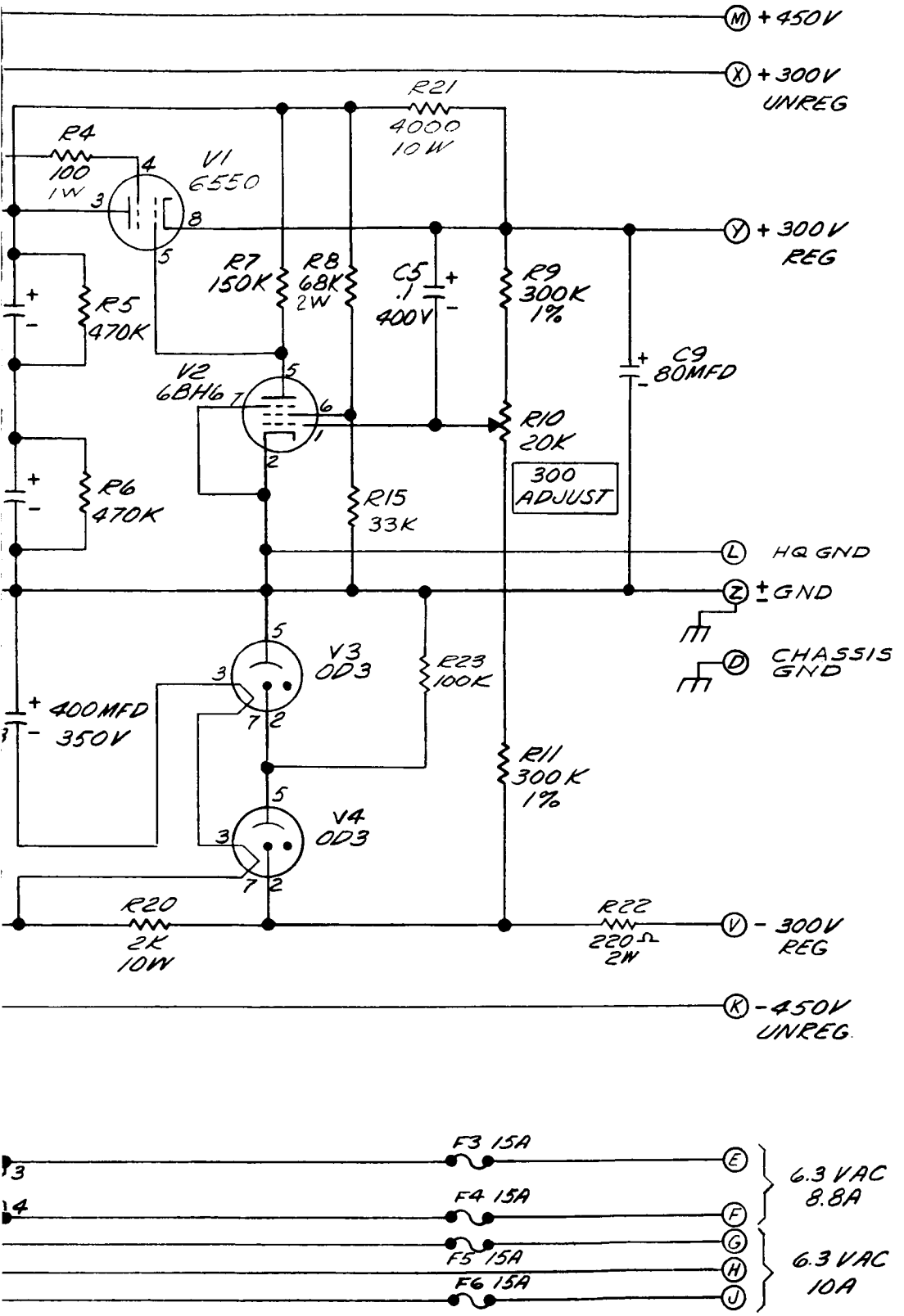
Figure 7-3a. Wiring Diagram

Servo Supply

Dwg. #15W72A



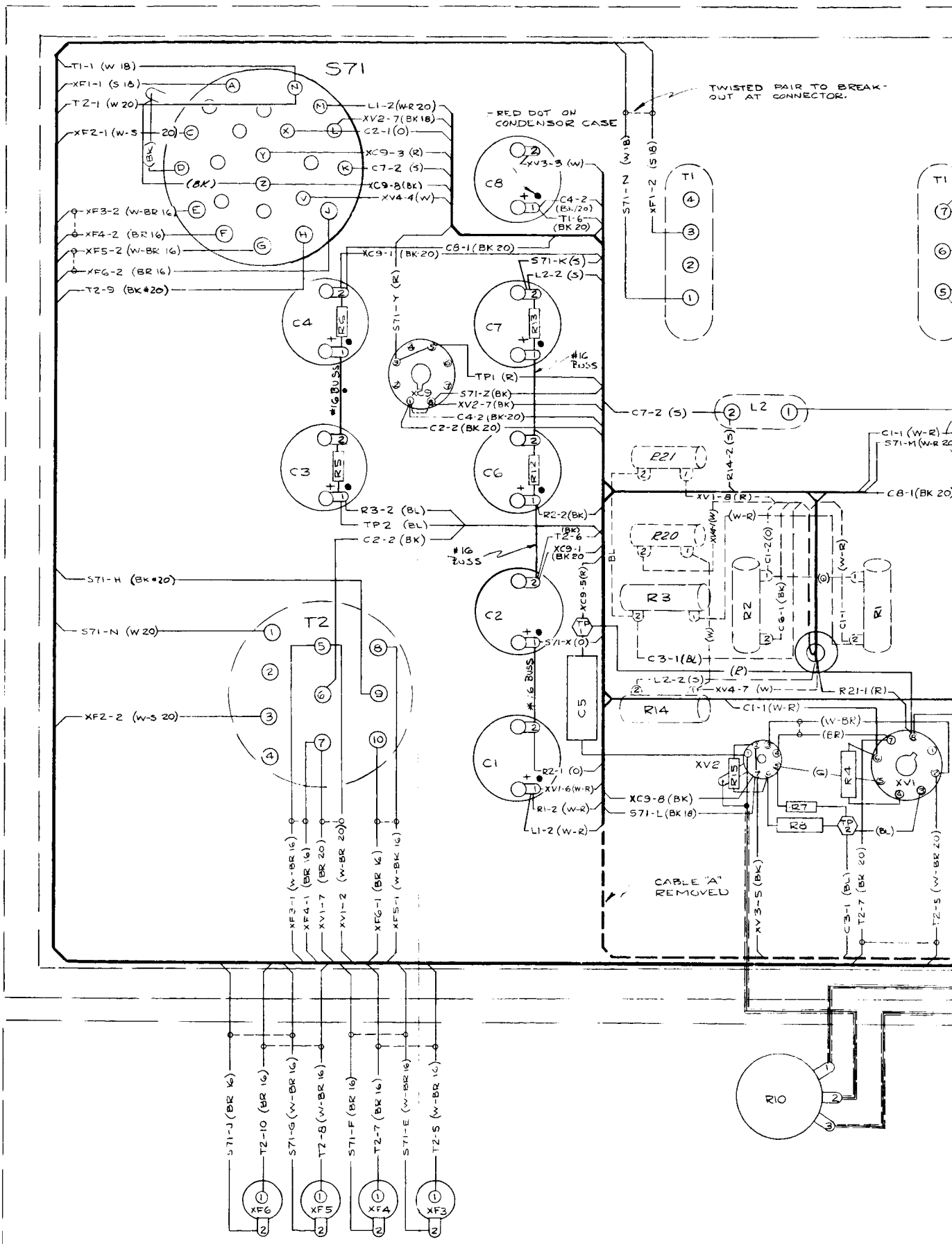
NOTE:
UNLESS OTHERWISE SPECI
CAPACITANCE IS IN MFD.
RESISTANCE IS IN OHMS
RESISTORS ARE 1/2 WAT

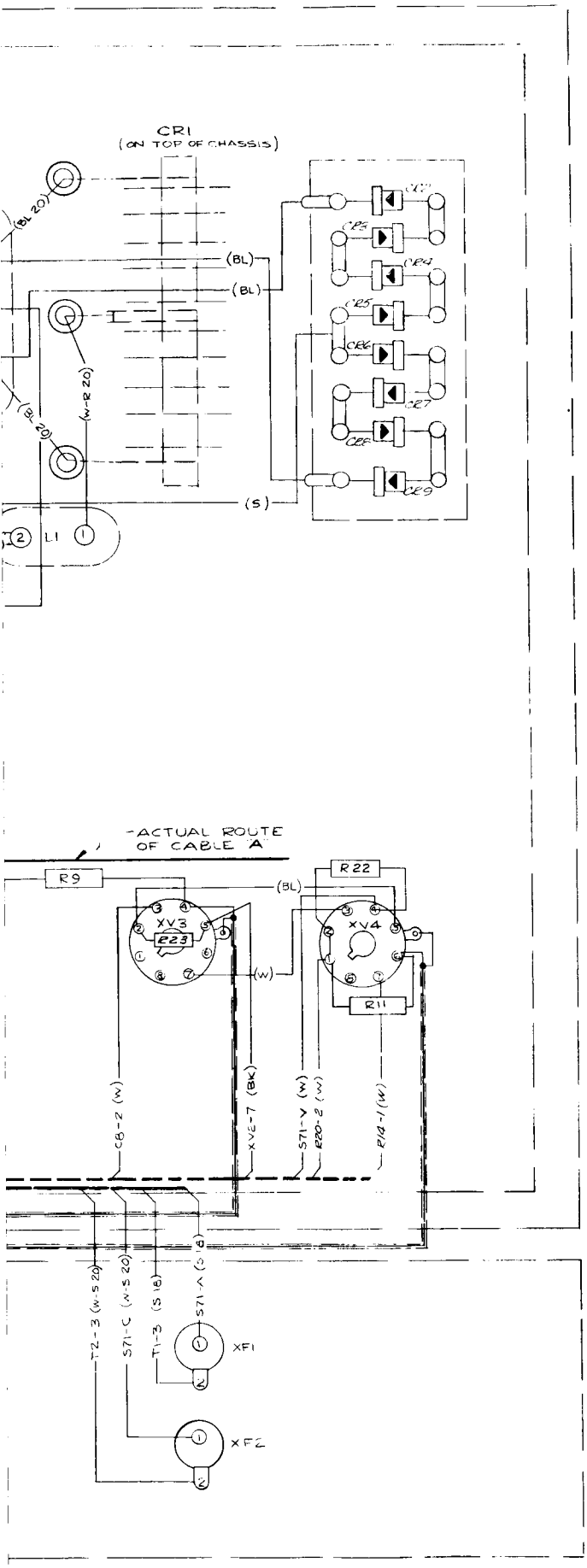


FIED;

;±10%

Figure 7-4. Schematic, Power Supply

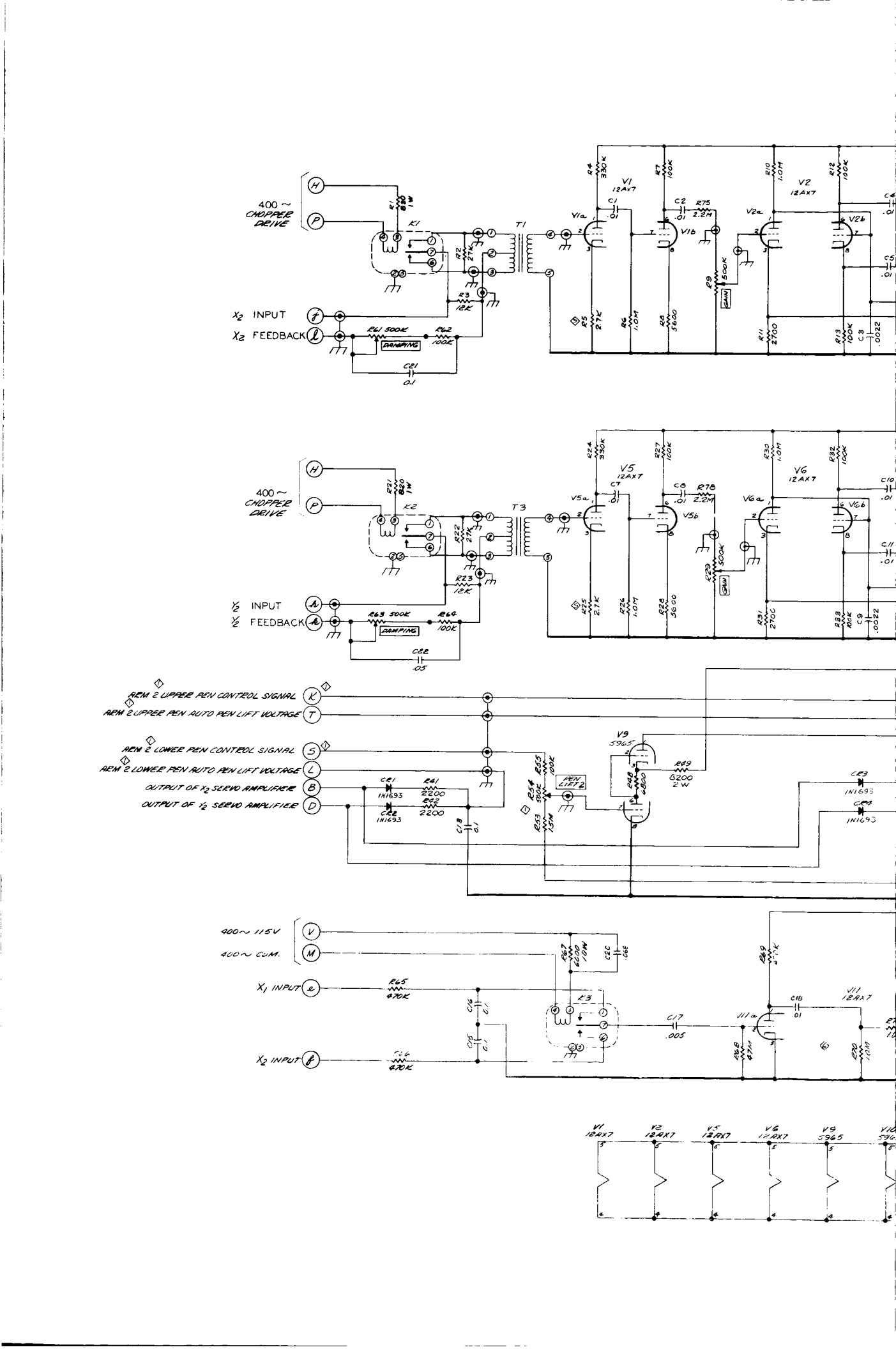

S71
T1-1 (W 18)
XF1-1 (S 18)
T2-1 (W 20)
XF2-1 (W-S 20)
XF3-2 (W-BR 16)
XF4-2 (BR 16)
XF5-2 (W-BR 16)
XF6-2 (BR 16)
T2-9 (BK #20)
L1-2(W-R 20)
XV2-7(BK 18)
C2-1(O)
XC9-3 (R)
C7-2 (S)
XC9-8(BK)
XV4-4(W)
(BK)
RED DOT ON CONDENSOR CASE
TWISTED PAIR TO BREAK-OUT AT CONNECTOR.
XV3-3 (W)
C4-2 (BL-20)
T1-6 (BK 20)
S71-Z (W 18)
XF1-2 (S 18)
T1
C8
C4
C7
C3
C6
C2
C1
C5
R5
R6
R13
R12
R2-1 (O)
XV1-6(W-R)
R1-2 (W-R)
L1-2 (W-R)
XC9-1 (BK-20)
C8-1(BK 20)
S71-K(S)
L2-2 (S)
S71-Y (R)
#16 BUSS
TP1 (R)
S71-Z(BK)
XV2-7(BK)
C4-2(BK-20)
C2-2(BK 20)
C7-2 (S)
L2
R21
R14-2 (S)
C1-1 (W-R)
S71-M (W-R 20)
C8-1(BK 20)
XV1-8(R)
R20
XV4-7(W)
(W-R)
C1-2(O)
C6-1 (BK)
R3
R2
R1
C1-1
(W-R)
R3-2 (BL)
TP2 (BL)
C2-2 (BK)
T2-6 (BK)
XC9-1 (BK 20)
XC9-5(R)
TP
S71-X(O)
C3-1(BL)
(P)
L2-2(S)
XV4-7 (W)
R21-1(R)
R14
C1-1(W-R)
(W-BK)
(BR)
XV2
XV1
R15
R4
(G)
R7
R8
TP2
(BL)
XC9-8(BK)
S71-L(BK 18)
BL
S71-H (BK #20)
S71-N (W 20)
XF2-2 (W-S 20)
T2
XF3-1 (W-BR 16)
XF4-1 (BR 16)
XV1-7 (BR 20)
XV1-2 (W-BR 20)
XF6-1 (BR 16)
XF5-1 (W-BK 16)
CABLE "A" REMOVED
XV3-5 (BK)
C3-1 (BL)
T2-7 (BK 20)
T2-5 (W-BR 20)
S71-J (BR 16)
T2-10 (BR 16)
S71-G (W-BR 16)
T2-8 (W-BR 16)
S71-F (BR 16)
T2-7 (BR 16)
S71-E (W-BR 16)
T2-5 (W-BR 16)
XF6
XF5
XF4
XF3
R10

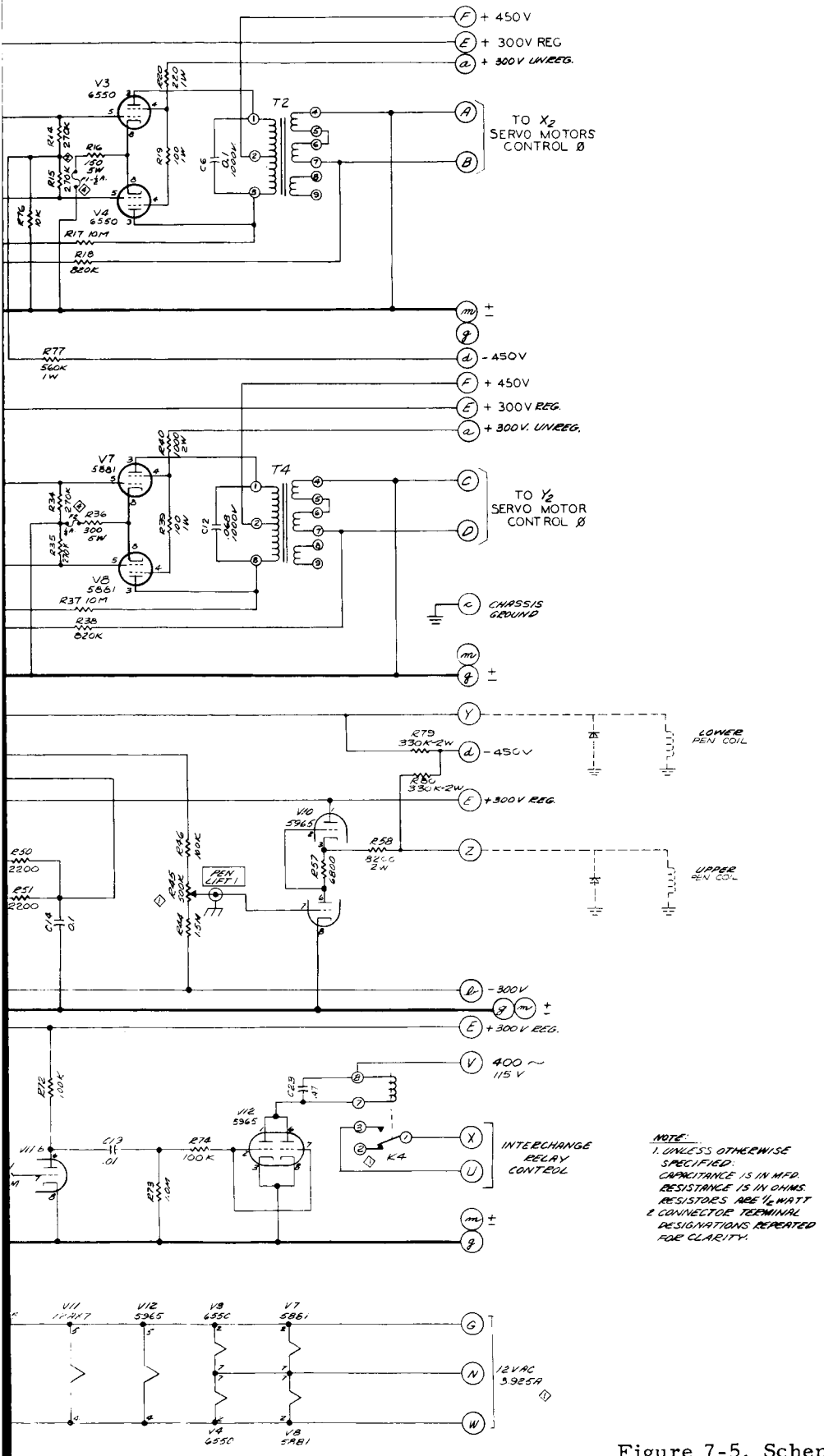


NOTES!

1. ALL JUMPERS SHOWN TO BE #20 BUS.
2. o—o INDICATES TWISTED PAIR.
3. ALL WIRES UNLESS OTHERWISE SPECIFIED TO BE #22 GAGE.
4. ═══ INDICATES COAX RG 174/U.
5. COVER DIODES CR2 THRU CR9 WITH SLEEVING.

Figure 7-4a. Wiring Diagram Power Supply Dwg. #15W71A


400 ~ CHOPPER DRIVE
X2 INPUT
X2 FEEDBACK
DAMPING
K1
T1
V1 12AX7
V2 12AX7
V1a
V1b
V2a
V2b
R1 820 1W
R2 27K
R3 12K
R61 500K
R62 100K
C21 0.1
R4 330K
R5 27K
R6 1.0M
R7 100K
R8 3600
C1 .01
C2 .01
R75 2.2M
R9 500K
R10 1.0M
R11 2700
R12 100K
R13 100K
C3 .0022
C4 .01
C5 .01
400 ~ CHOPPER DRIVE
½ INPUT
½ FEEDBACK
K2
T3
V5 12AX7
V6 12AX7
V5a
V5b
V6a
V6b
R21 820 1W
R22 27K
R23 12K
R63 500K
R64 100K
C22 .05
R24 330K
R25 27K
R26 1.0M
R27 100K
R28 3600
C7 .01
C8 .01
R78 2.2M
R29 500K
R30 1.0M
R31 2700
R32 100K
R33 100K
C9 .0022
C10 .01
C11 .01
ARM 2 UPPER PEN CONTROL SIGNAL
ARM 2 UPPER PEN AUTO PEN LIFT VOLTAGE
ARM 2 LOWER PEN CONTROL SIGNAL
ARM 2 LOWER PEN AUTO PEN LIFT VOLTAGE
OUTPUT OF X2 SERVO AMPLIFIER
OUTPUT OF ½ SERVO AMPLIFIER
CR1 IN1693
CR2 IN1693
R41 2200
R42 2200
C13 .01
R34 500K
R35 100K
R33 1.5M
PEN LIFT 2
V9 5965
R49 6200 2W
CR3 IN1693
CR4 IN1693
400~ 115V
400~ COM.
X1 INPUT
X2 INPUT
R67 6200 10W
C2C .05
R45 470K
R46 470K
C16 .01
C25 .01
K3
C17 .005
V11 12AX7
C18 .01
R69 47K
R70 1.0M
V1 12AX7
V2 12AX7
V5 12AX7
V6 12AX7
V9 5965

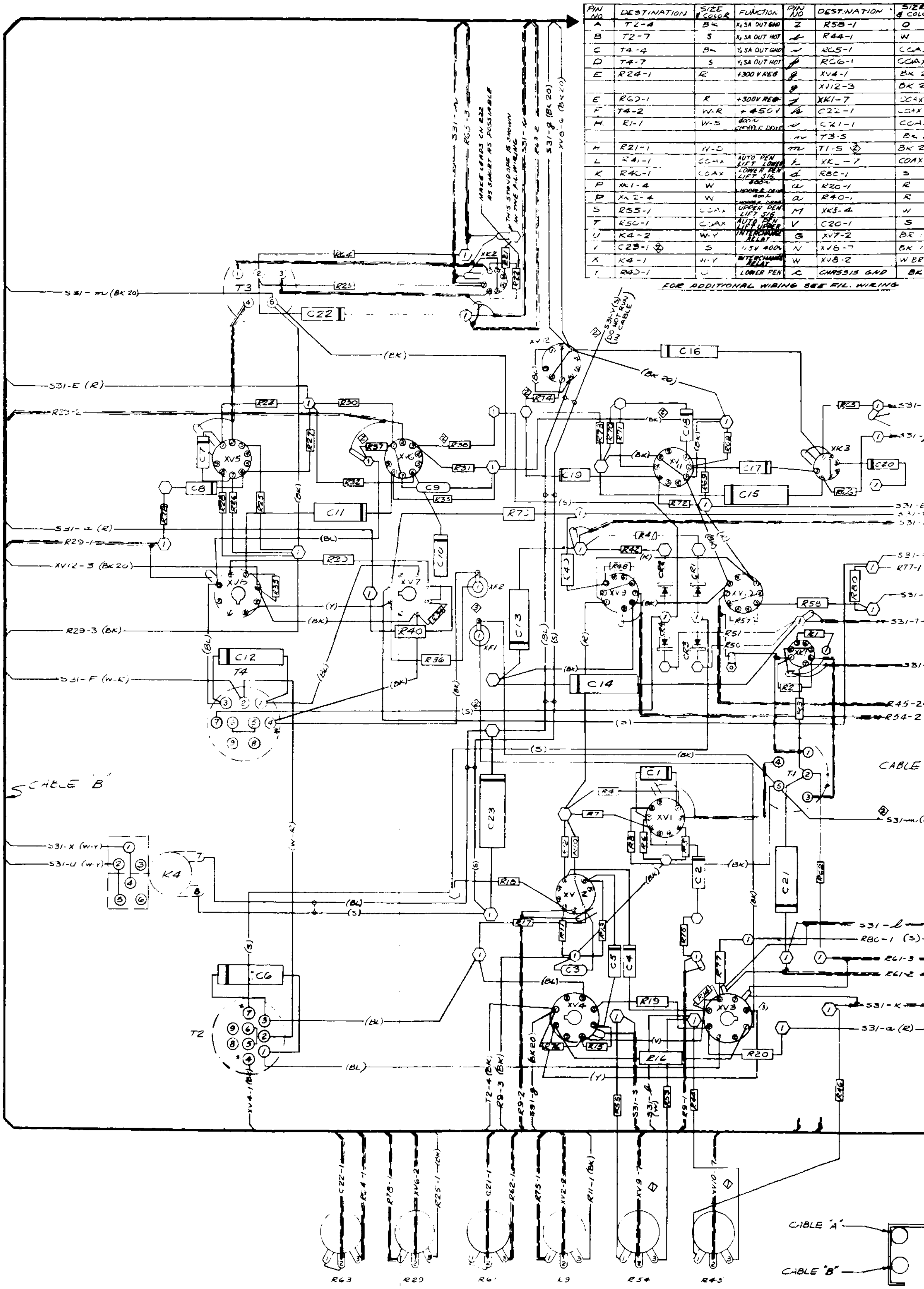


NOTE:
1. UNLESS OTHERWISE SPECIFIED: CAPACITANCE IS IN MFD. RESISTANCE IS IN OHMS. RESISTORS ARE 1/2 WATT
2. CONNECTOR TERMINAL DESIGNATIONS REPEATED FOR CLARITY.

Figure 7-5. Schematic, Servo Amplifier

PIN NO	DESTINATION	SIZE & COLOR	FUNCTION	PIN NO	DESTINATION	SIZE & COLOR
A	T2-4	BK	X_1 SA OUT GND	Z	R58-1	O
B	T2-7	S	X_1 SA OUT HOT	b	R44-1	W
C	T4-4	BK	Y_1 SA OUT GND	c	R65-1	COAX
D	T4-7	S	Y_1 SA OUT HOT	f	R66-1	COAX
E	R24-1	R	+300 V REG	g	XV4-1	BK 2
				g	XV12-3	BK 2
E	R63-1	R	+300V REG	j	XK1-7	COAX
F	T4-2	W-R	+450V	h	C22-1	COAX
H.	R1-1	W-S	400~ CHOPPER DRIVE	e	C21-1	COAX
				n	T3-5	BK
H	R21-1	W-S		m	T1-5 ②	BK 2
L	R41-1	COAX	AUTO PEN LIFT LOWER	k	XK_-7	COAX
K	R40-1	COAX	LOWER PEN LIFT SIG	d	R80-1	S
P	XK1-4	W	400~ CHOPPER DRIVE	u	R20-1	R
P	XK2-4	W	400~ CHOPPER DRIVE	a	R40-1	R
S	R55-1	COAX	UPPER PEN LIFT SIG	M	XK3-4	W
T	R50-1	COAX	AUTO PEN LIFT UPPER	V	C20-1	S
U	K4-2	W-Y	INTERCHANGE RELAY	G	XV7-2	BR
V	C23-1 ②	S	115V 400~	N	XV6-7	BK
X	K4-1	W-Y	INTERCHANGE RELAY	W	XV8-2	W-BR
Y	R43-1	O	LOWER PEN	c	CHASSIS GND	BK

FOR ADDITIONAL WIRING SEE FIL. WIRING



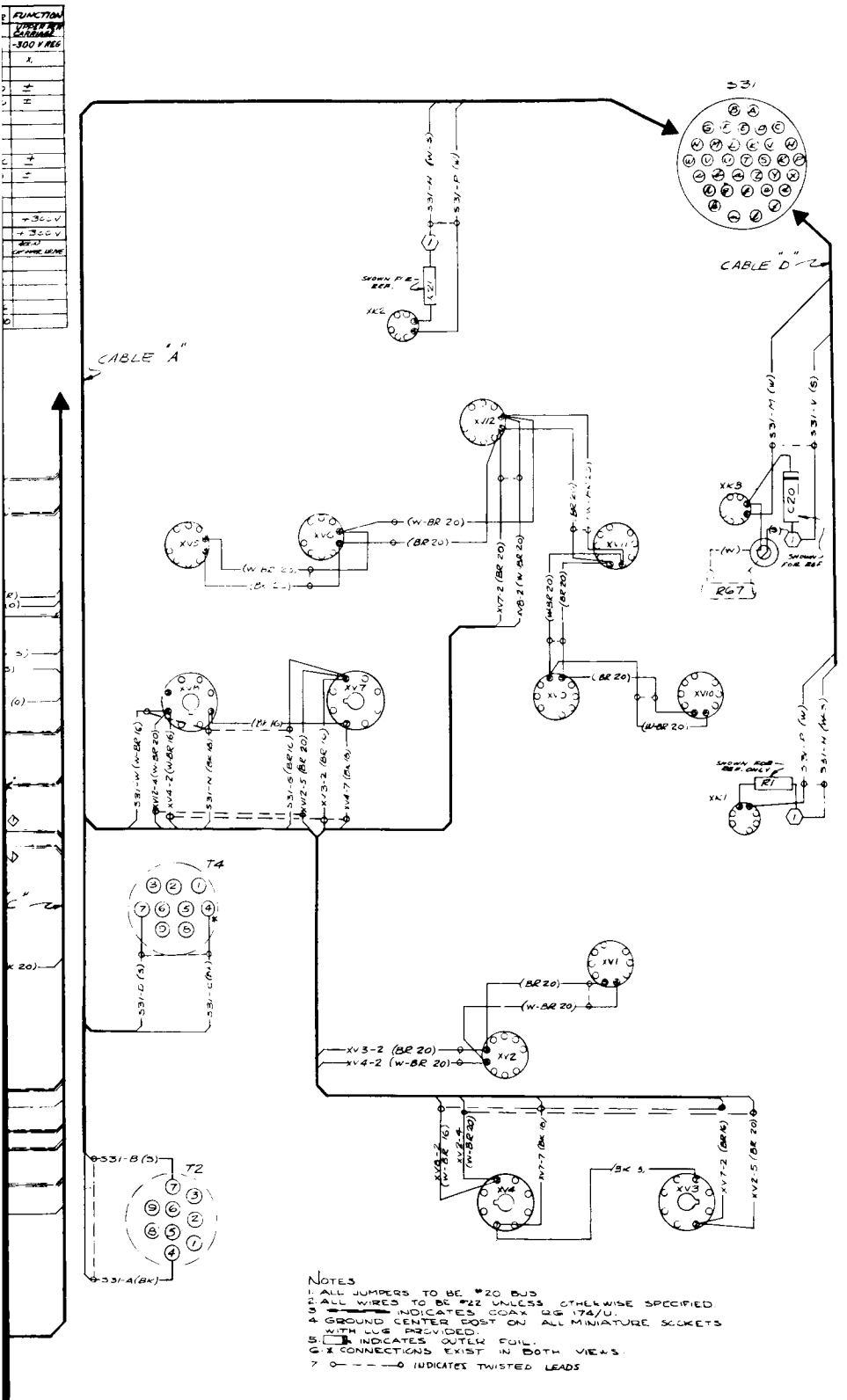
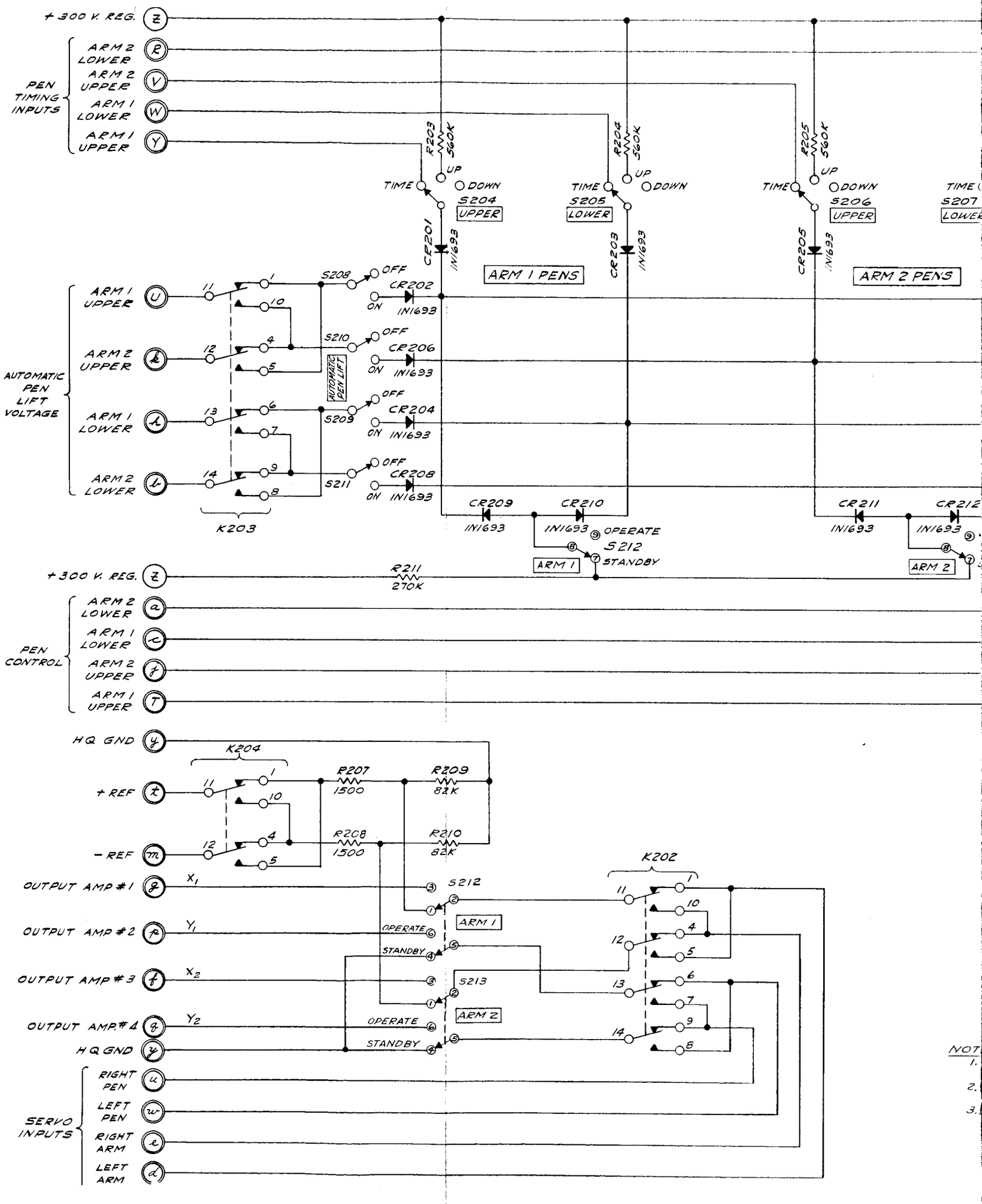
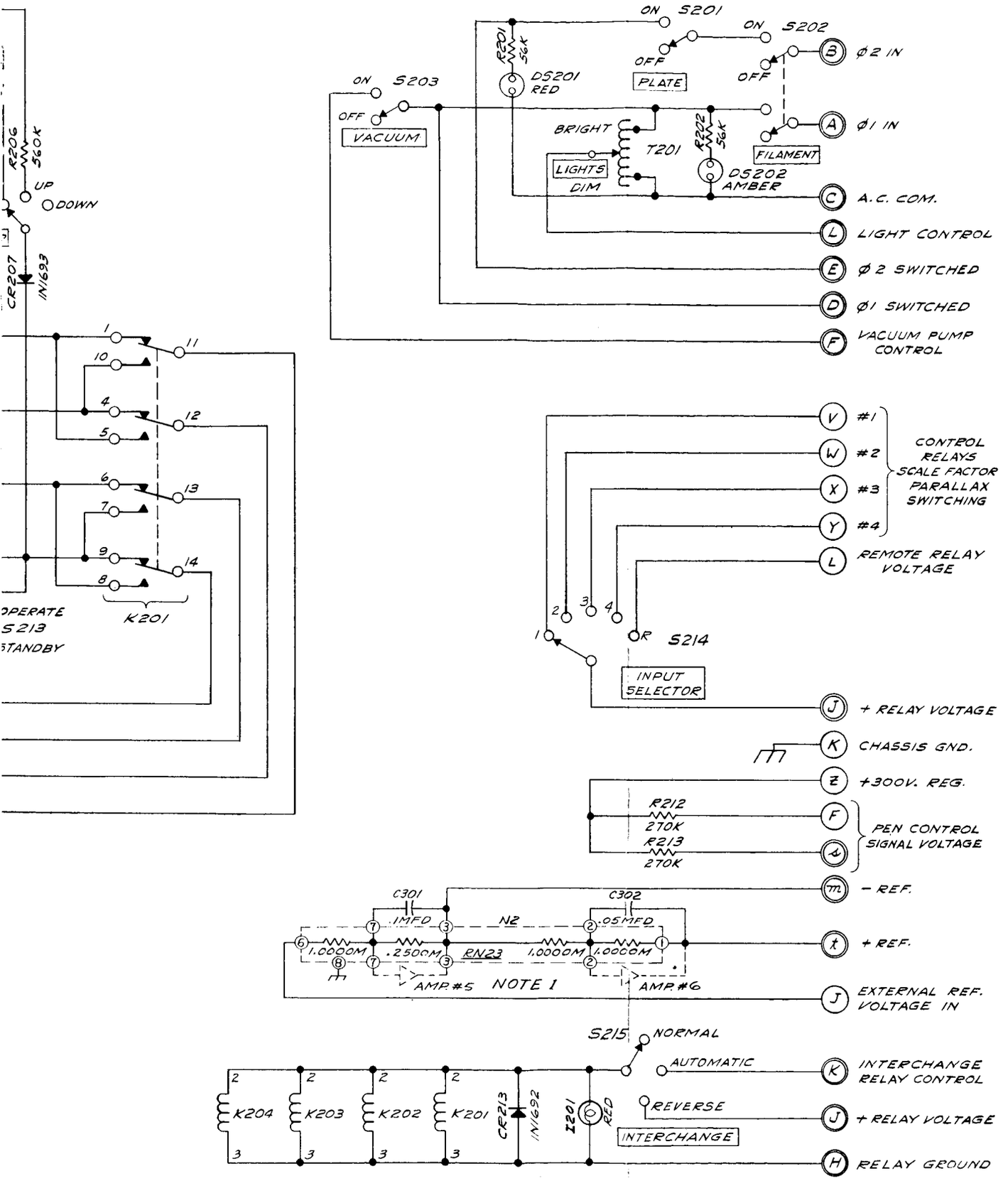


Figure 7-5a. Wiring Diagram

Servo Amplifier

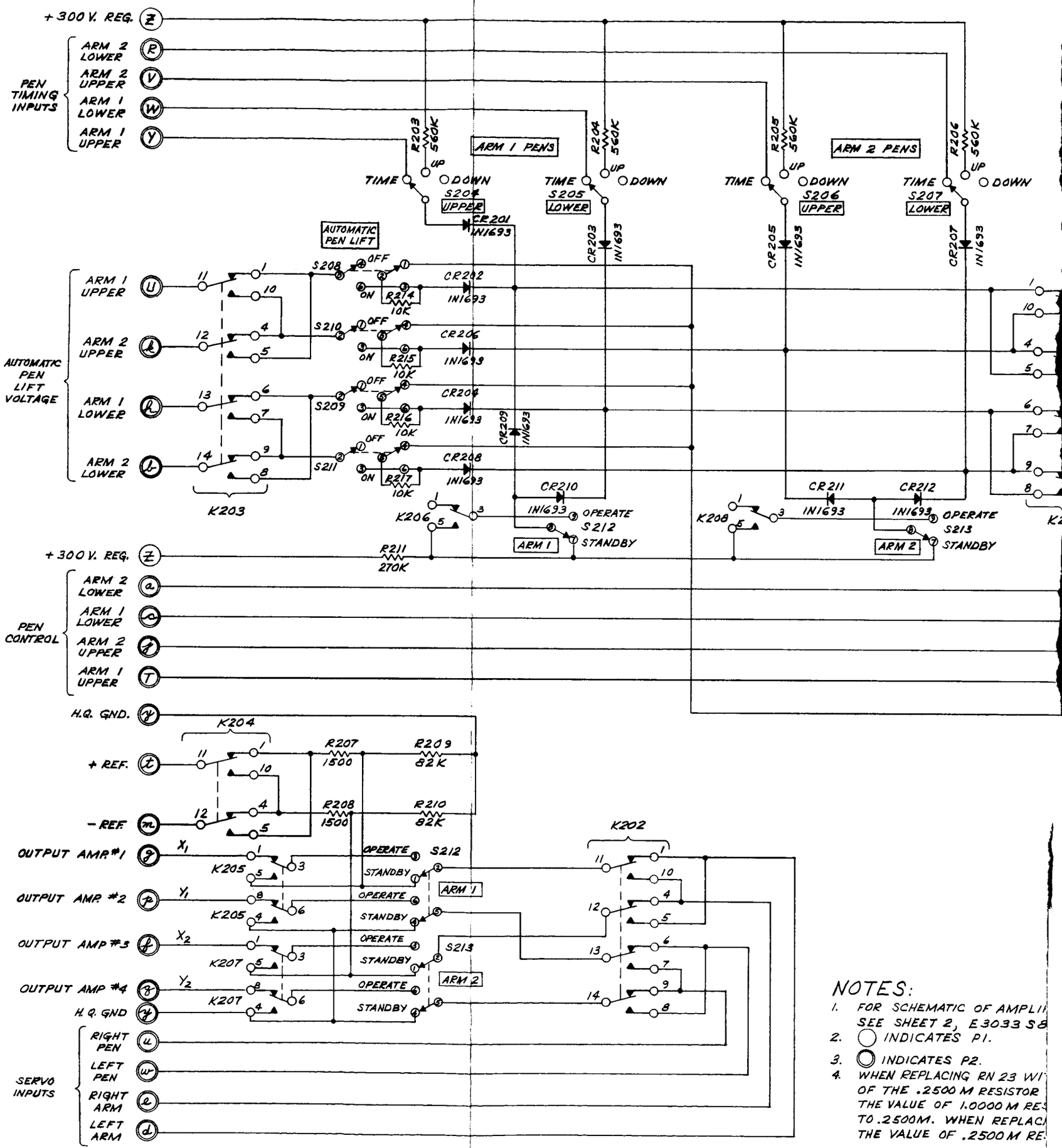
Dwg. #15W31A


+300 V. REG.
PEN TIMING INPUTS
ARM 2 LOWER
ARM 2 UPPER
ARM 1 LOWER
ARM 1 UPPER
R203 560K
R204 560K
R205 560K
UP
DOWN
TIME
S204 UPPER
S205 LOWER
S206 UPPER
S207 LOWER
CR201 IN1693
CR203 IN1693
CR205 IN1693
ARM 1 PENS
ARM 2 PENS
AUTOMATIC PEN LIFT VOLTAGE
S208
S210
S209
S211
OFF
ON
CR202 IN1693
CR206 IN1693
CR204 IN1693
CR208 IN1693
AUTOMATIC PEN LIFT
K203
CR209 IN1693
CR210 IN1693
CR211 IN1693
CR212 IN1693
OPERATE
STANDBY
S212
ARM 1
ARM 2
+300 V. REG.
R211 270K
PEN CONTROL
HQ GND
K204
+ REF
- REF
R207 1500
R208 1500
R209 82K
R210 82K
OUTPUT AMP #1
OUTPUT AMP #2
OUTPUT AMP #3
OUTPUT AMP #4
X1
Y1
X2
Y2
S213
K202
SERVO INPUTS
RIGHT PEN
LEFT PEN
RIGHT ARM
LEFT ARM



ES:
FOR SCHEMATIC OF AMPLIFIER #5 AND #6, SEE SHEET 2.
INDICATES P1.
INDICATES P2.

Figure 7-6. Schematic, Control Unit



NOTES:

1. FOR SCHEMATIC OF AMPLI SEE SHEET 2, E3033 S
2. ◯ INDICATES P1.
3. ◯ INDICATES P2.
4. WHEN REPLACING RN 23 WI OF THE .2500 M RESISTOR THE VALUE OF 1.0000 M RE TO .2500M. WHEN REPLAC THE VALUE OF .2500 M RE

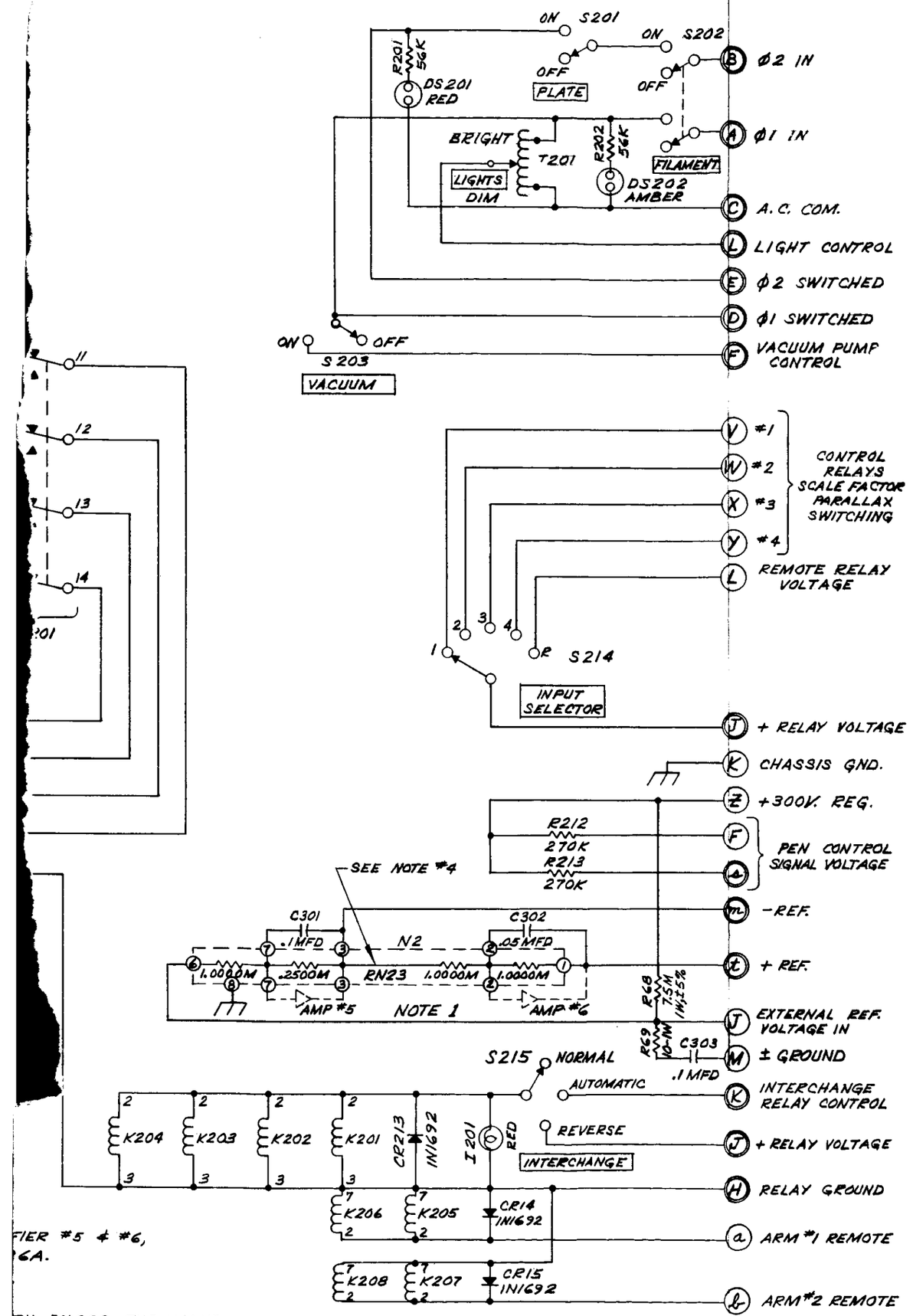
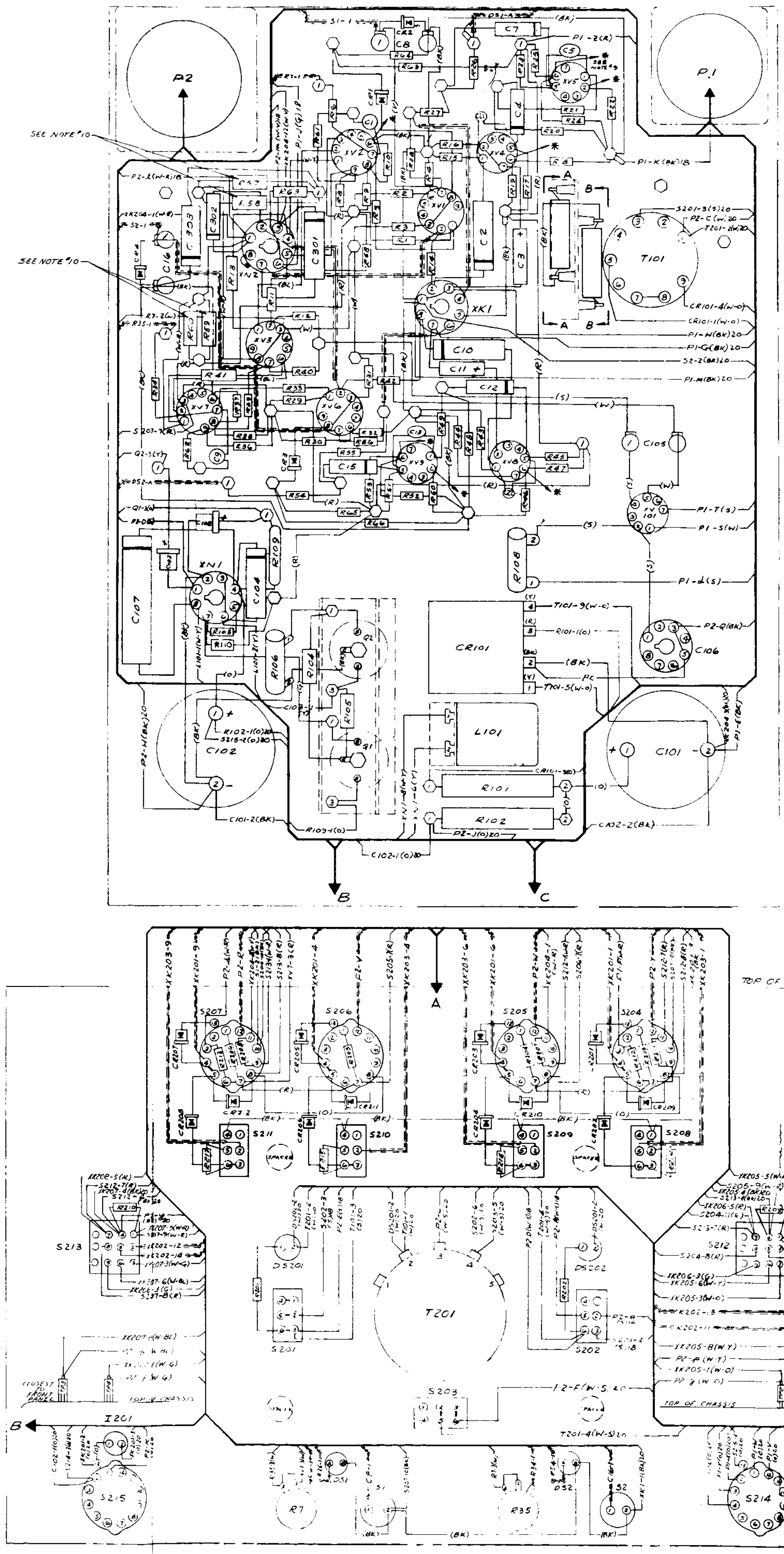
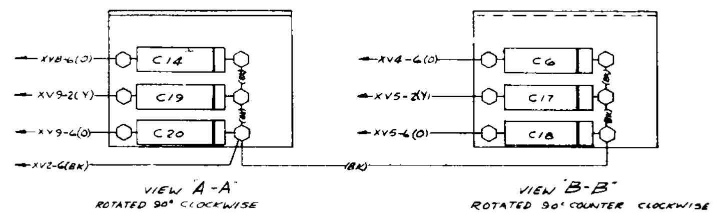


Figure 7-6a. Control Unit Modified per IBM Spec. #3218307 Schematic (D1580S86A)

P2			
TERMINAL	DESTINATION	WIRE SIZE & COLOR	IDENTIFICATION
A	S202-5	18(W-S)	Ø1 IN
B	S202-2	18(S)	Ø2 IN
C	◀ T101-1	20(W)	AC COMMON
D	S202-6	18(W-S)	Ø1 SWITCHED
E	S201-3	18(S)	Ø2 SWITCHED
F	S203-6	20(W-S)	VACUUM PUMP CONTROL
H	◀ C102-2	20(BK)	RELAY GROUND
J	◀ R102-1	20(O)	+ RELAY VOLTAGE
K	S215-1	20(O)	INT RELAY CONTROL
L	T201-3	20(W-S)	LIGHT CONTROL
G	◀ C106-3	BK	± GND
R	S207-12		ARM #2 LOWER PEN TIMING INPUT
T	XK201-11		ARM #1 UPPER PEN CONTROL
U	XK203-11		ARM #1 UPPER PEN (AUTO LIFT VOLTAGE)
V	S206-12		ARM #2 UPPER PEN TIMING INPUT
W	S205-12		ARM #1 LOWER PEN TIMING INPUT
Y	S204-12		ARM #1 UPPER PEN TIMING INPUT
a	XK201-14		ARM #2 LOWER PEN CONTROL
b	XK203-14		ARM #2 LOWER PEN (AUTO PEN LIFT VOLT.)
c	XK201-13		ARM #1 LOWER PEN CONTROL
d	XK202-1		LEFT ARM SERVO INPUT
e	XK202-4		RIGHT ARM SERVO INPUT
f	TP4	(W-G)	AMP #5 OUTPUT (X_2)
g	TP2	(W-O)	AMP #3 OUTPUT (X_1)
h	XK203-13		ARM #1 LOWER PEN (AUTO PEN LIFT VOLT.)
j	XK201-12		ARM #2 UPPER PEN CONTROL
k	XK203-12		ARM #2 UPPER PEN (AUTO PEN LIFT VOLT.)
m	■ XN2-3	18(W-V)	- REF
n	TP1	(W-Y)	AMP #4 OUTPUT (Y_1)
p	TP3	(W-BL)	AMP #6 OUTPUT (Y_2)
s	S207-8	(W-R)	PEN CONTROL SIGNAL VOLTAGE
r	■ XN2-1	18(W-R)	+ REF
u	XK202-9		RIGHT PEN SERVO INPUT
w	XK202-6		LEFT PEN SERVO INPUT
x	S213-4	BK	HQ GND



P1			
TERMINAL	DESTINATION	WIRE SIZE & COLOR	IDENTIFICATION
A	■ XV5-4	20(BK)	FIL CT (GND)
B	■ XV5-3	20(W-BR)	FIL (GND)
C	■ XV4-4	20(BR)	FIL (GND)
D	■ XN1-1	S	CHOPPER DRIVE (HOT)
E	◀ C101-2	BK	CHOPPER DRIVE (GND)
F	S204-3	(W-R)	PEN CONTROL SIGNAL VOLTAGE
G	■ XK1-7	20(BK)	HQ GND
H	■ XK1-3	20(BK)	HQ GND
J	■ XN2-6	18(G)	REF INPUT
K	GND LUG	18(BK)	CHASSIS GND
L	S214-4	20(O)	REMOTE RELAY VOLT.
M	■ XK1-1	20(BK)	± GND
P	■ XV3-4	20(W-BR)	FIL (-300V)
R	■ XV3-9	20(BR)	FIL (-300V)
S	◀ XV101-1	W	- 300V
T	◀ XV101-7	S	- 400V
V	S214-12	20(O)	RELAY CONTROL #1
W	S214-1	20(O)	RELAY CONTROL #2
X	S214-2	20(O)	RELAY CONTROL #3
Y	S214-3	20(O)	RELAY CONTROL #4
Z	■ R23-1	R	+ 300V
d	◀ R108-1	S	- 450V
JUMPER H & G TOGETHER			
D	■ CHOPPER CAP TERM. #1	20(S)	CHOPPER DRIVE (HOT)
E	■ CHOPPER CAP TERM. #2	20(BK)	CHOPPER DRIVE (GND)
a	XK205-2	20(W-G)	ARM #1 REMOTE
b	XK207-2	20(BL)	ARM #2 REMOTE



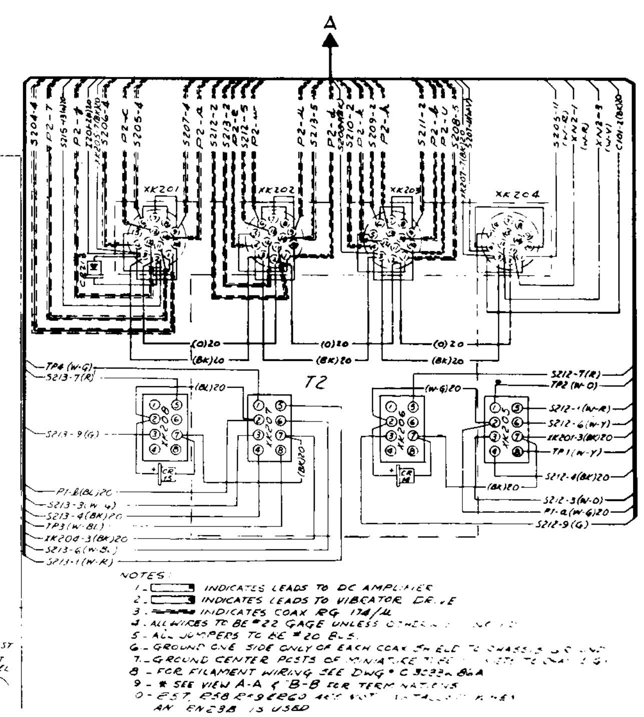
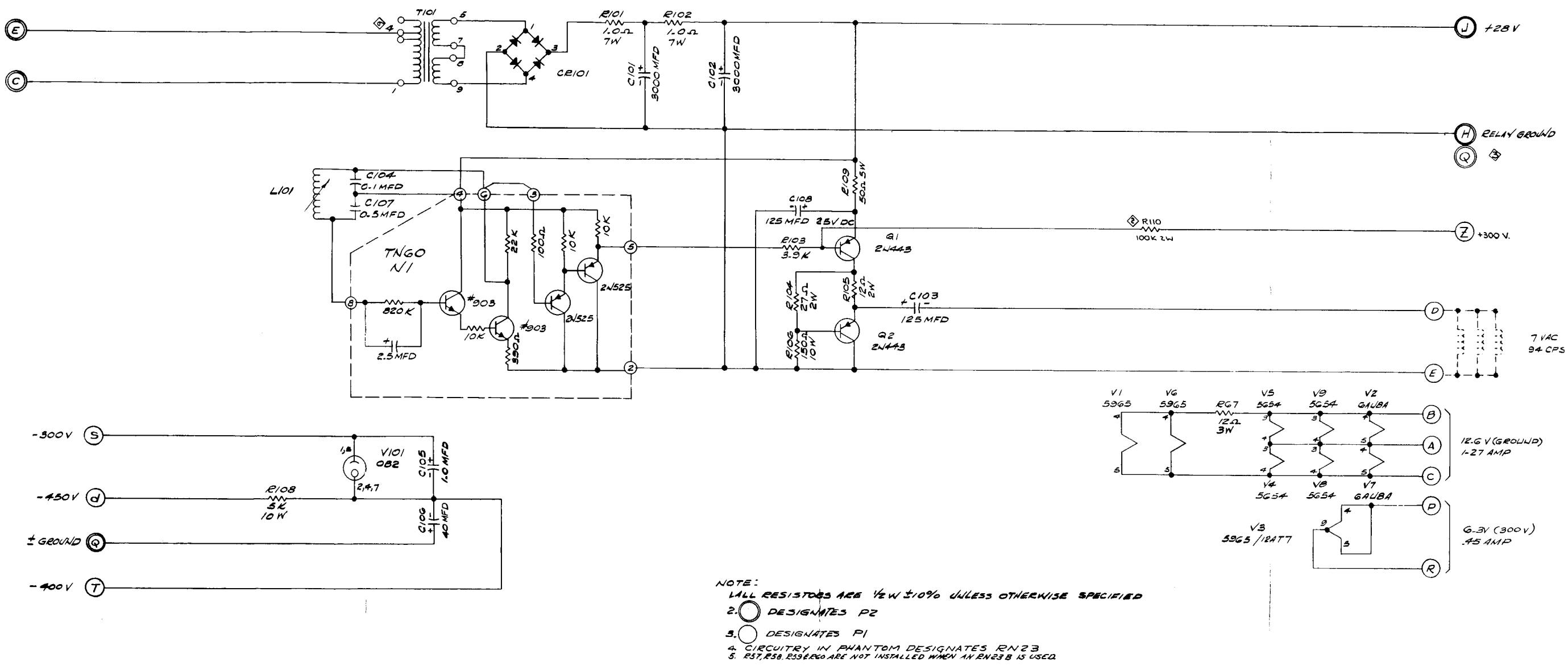


Figure 7-6b. Wiring Diagram
Control Unit modified per
IBM Spec. #3218307
Dwg. #1580W86A



NOTE:
1. ALL RESISTORS ARE 1/2 W ±10% UNLESS OTHERWISE SPECIFIED
2. ◯ DESIGNATES P2
3. ○ DESIGNATES P1
4. CIRCUITRY IN PHANTOM DESIGNATES RN23
5. R37, R38, R39 & R60 ARE NOT INSTALLED WHEN AN/RN23B IS USED

Figure 7-7. Schematic Diagram, Control Unit (Vibrator Drive)

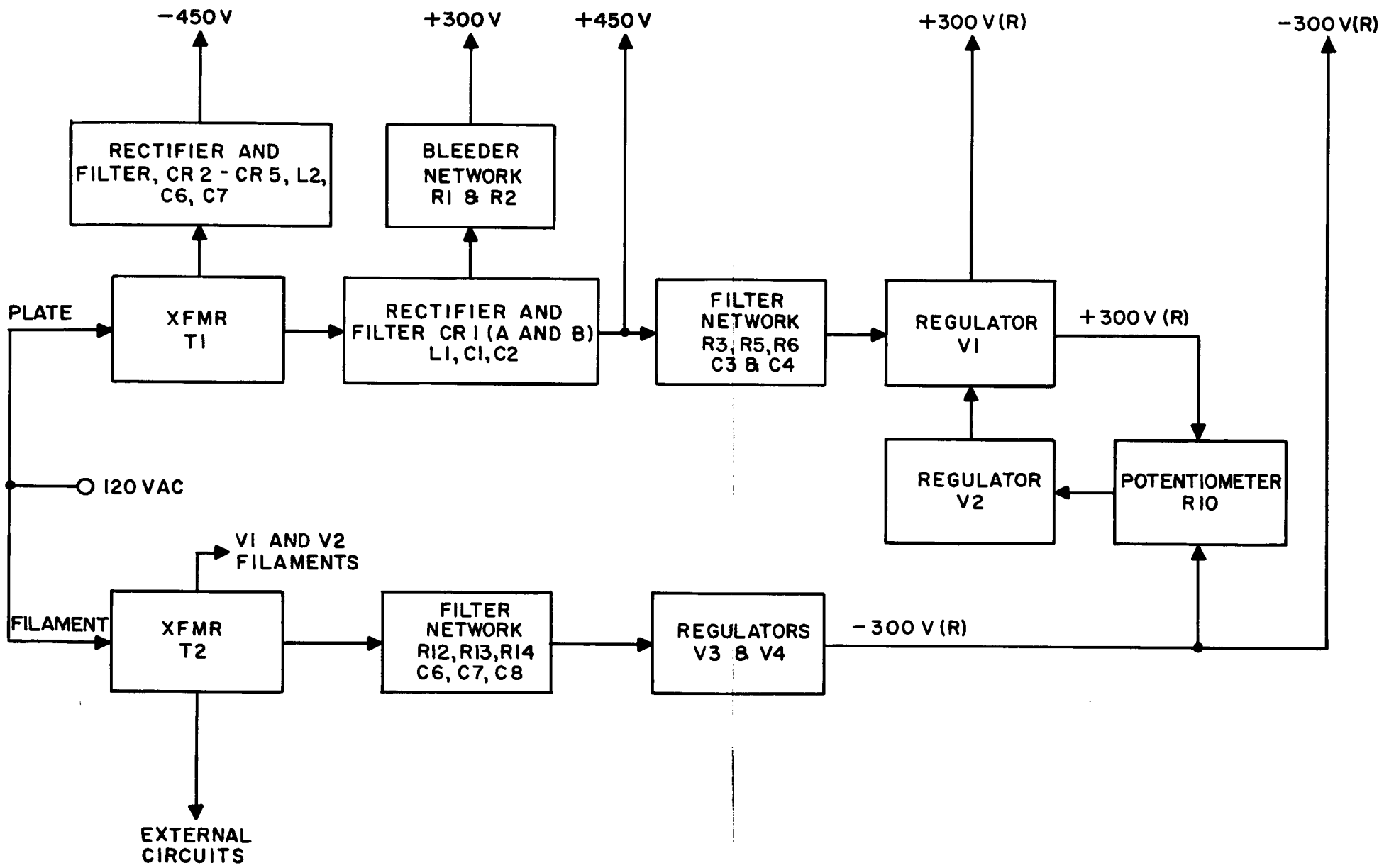


Figure 7-8. Block Diagram, Power Supply

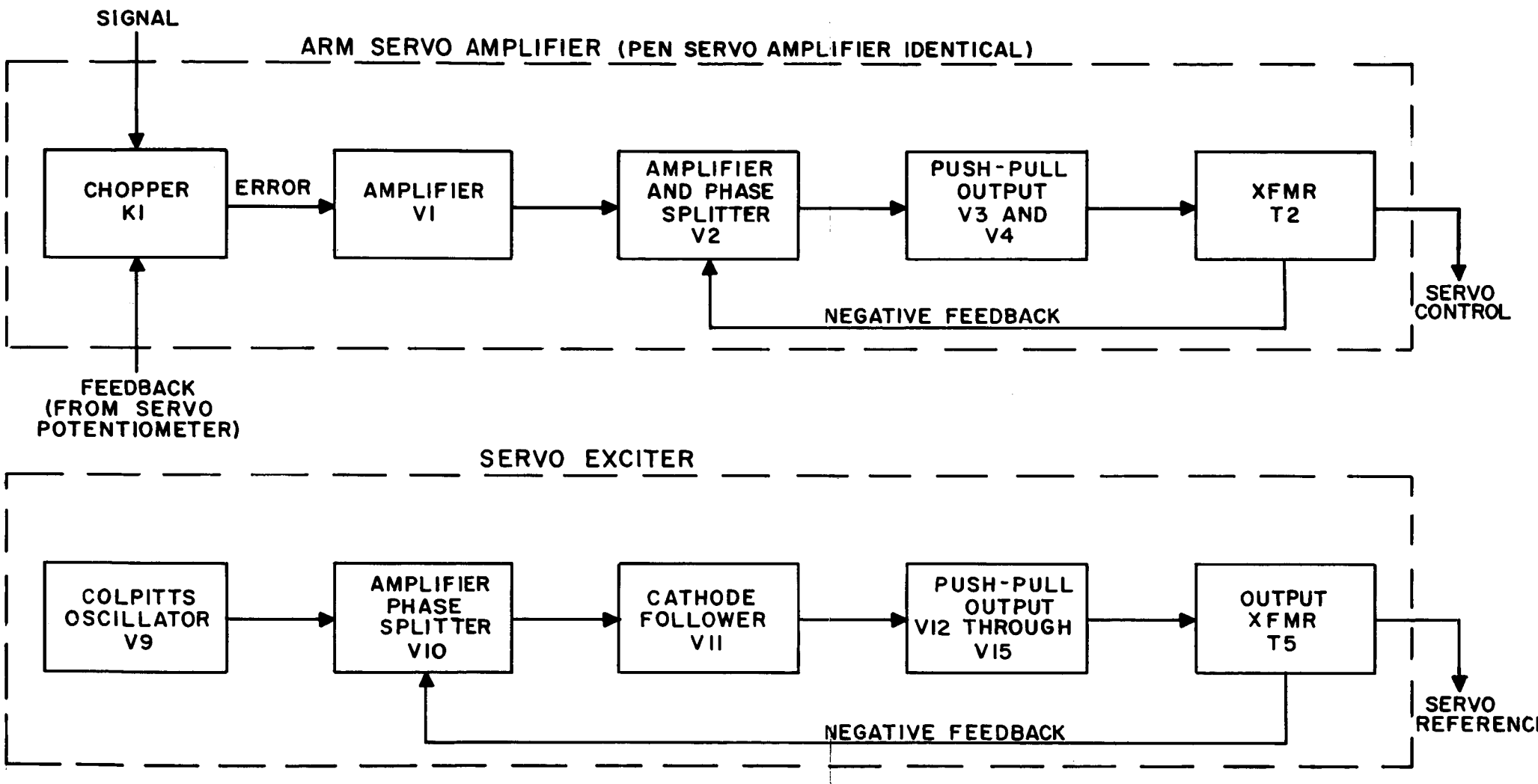


Figure 7-9. Block Diagram, Servo Amplifier

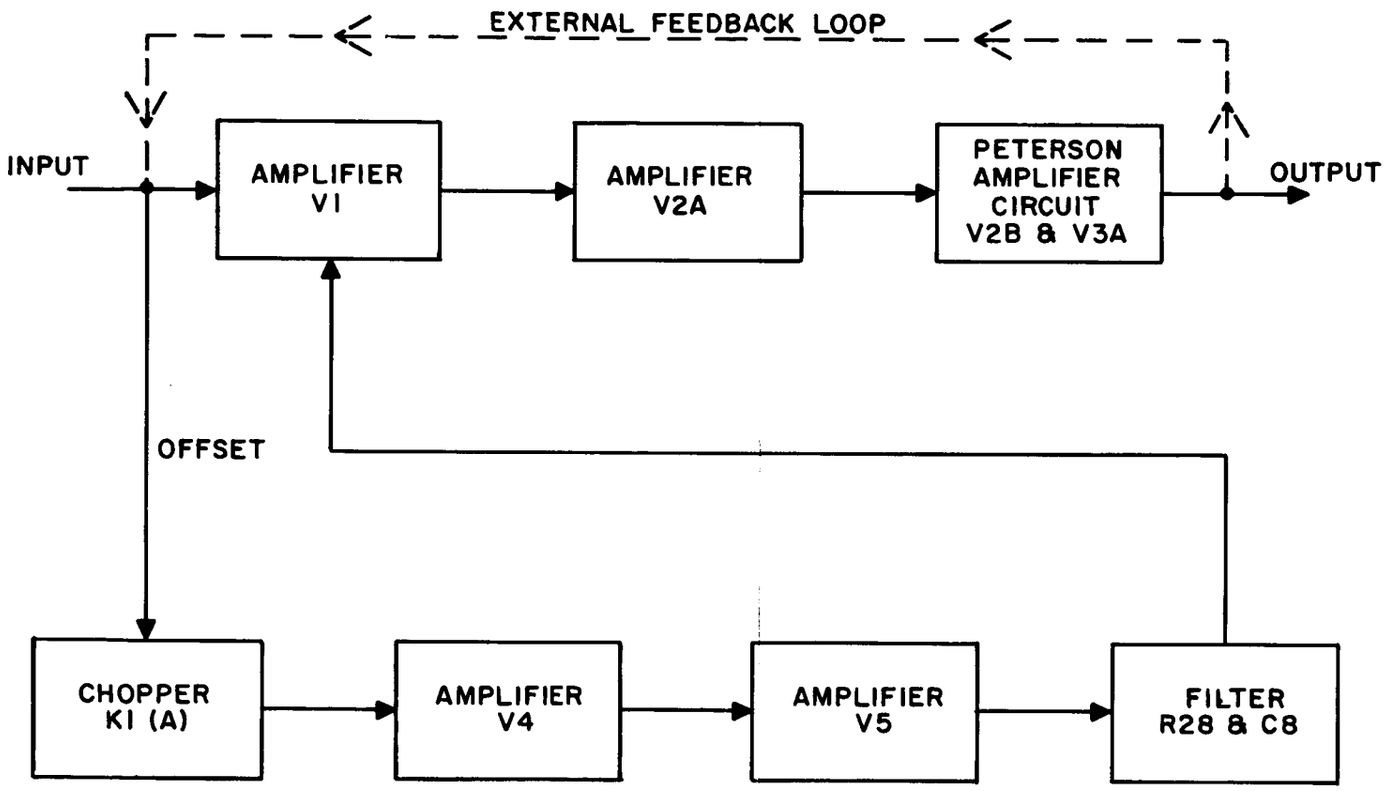
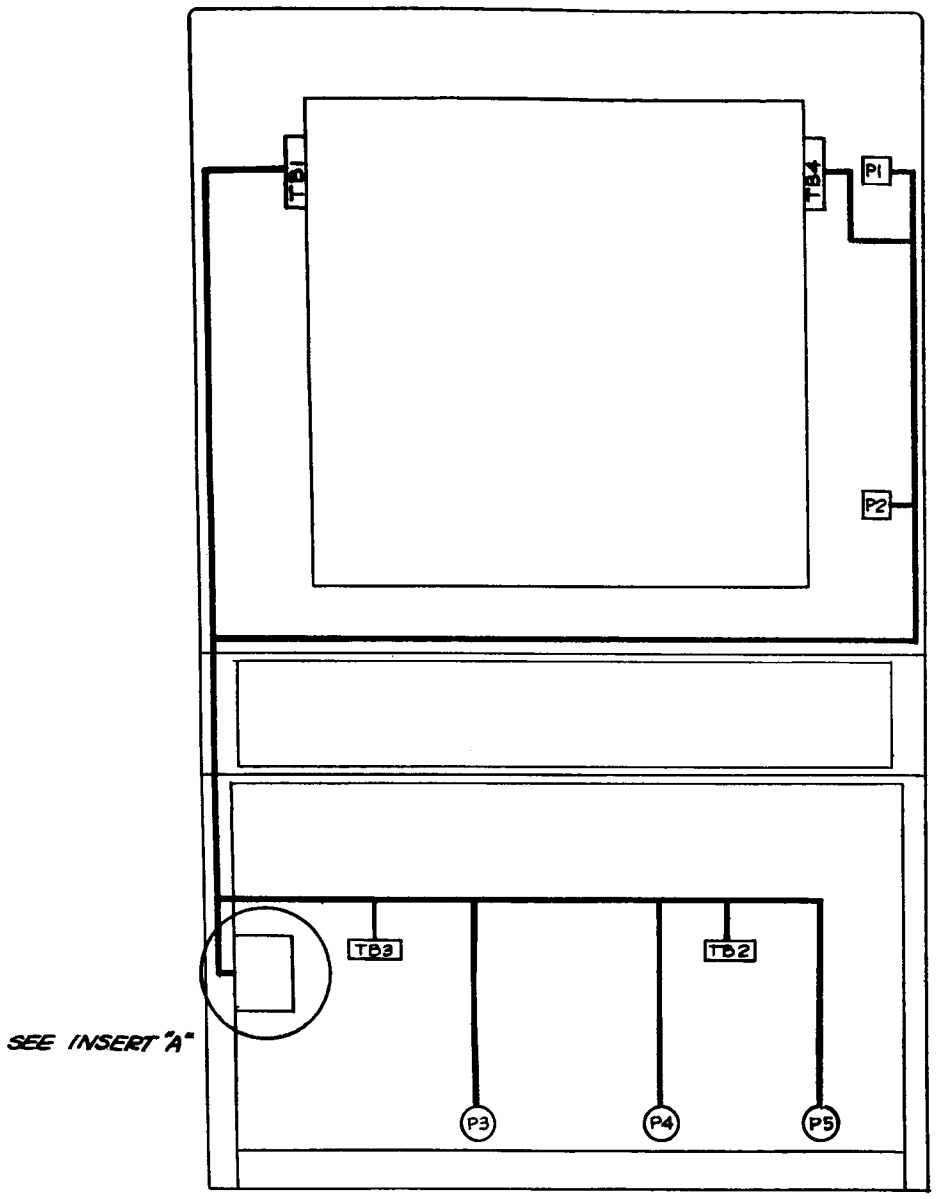
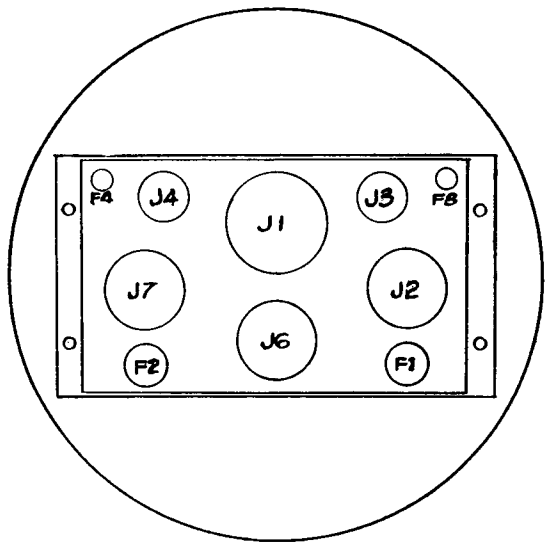


Figure 7-10 Block Diagram
One-half Dual D.C. Amplifier





INSERT "A"
(INSIDE VIEW OF PLUG MOUNTING BRACKET)

Figure 7-11. Cabling Diagram, X-Y Recorder

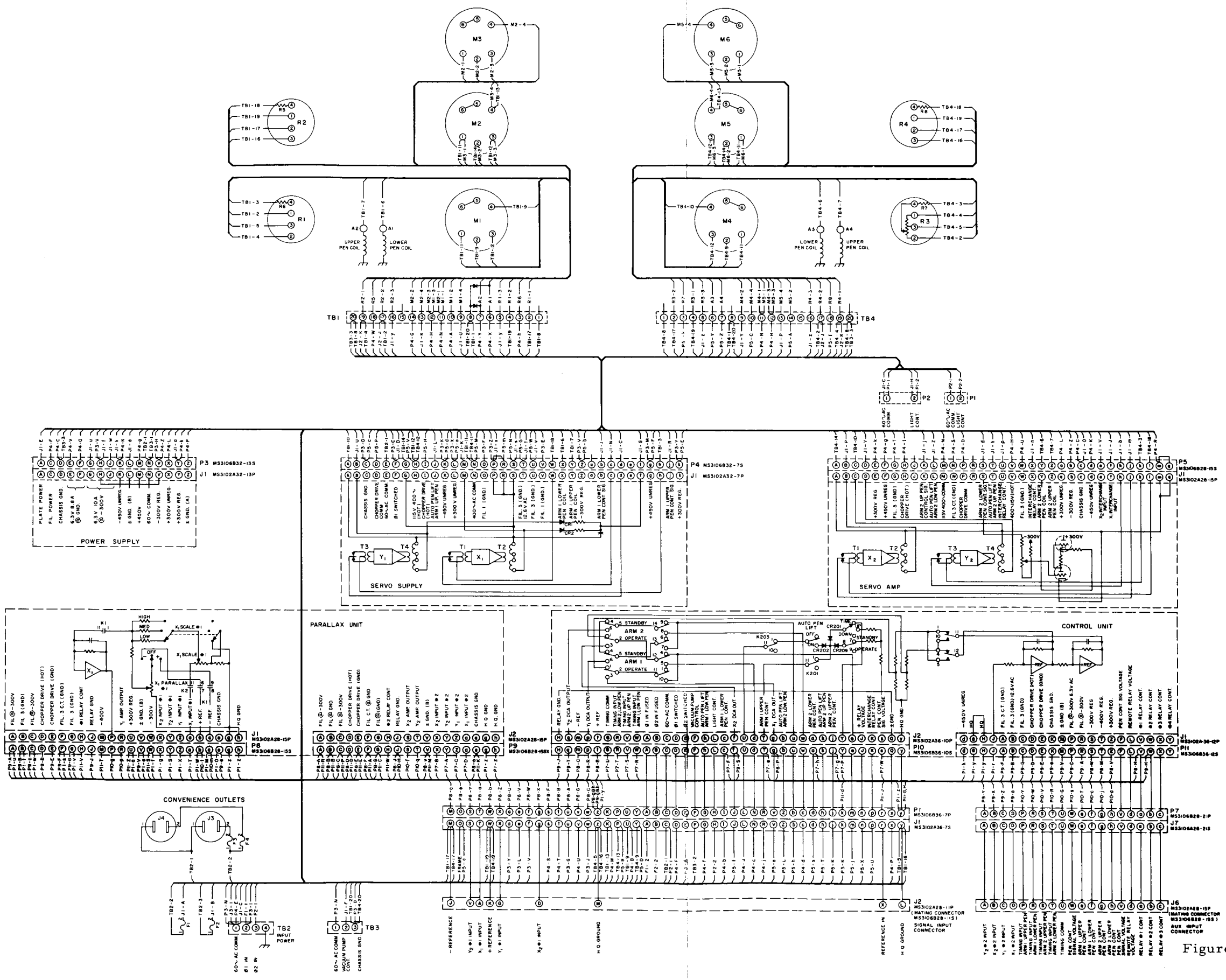


Figure 7-12. Wiring Diagram, X-Y Recorder,

section viii

ADDENDUM
FOR
MEC MODEL 3010 X-Y RECORDER
MODIFIED PER
I.B.M. SPEC. #3218307

SECTION VIII

8-1. GENERAL

This addendum, along with a revised Parts List on page 71 and figure 7-6a on page 109a, concisely covers the modification made to MEC Model 3010 X-Y Recorder. This modification was made to meet the requirements of IBM specification #3218307.

The reader should bear in mind that in the event of a contradiction between the manual proper and this addendum, the addendum supersedes.

8-2. MODIFICATION

The entire modification consisted of modifying one chassis and adding one chassis. The modified chassis is the Control Unit and the added chassis is an Auxiliary Control Unit.

8-2.1. Control Unit (See Figure 7-6a, p. 109a)

Remote-Standby relay K205 and K208 have been added. These relays are controlled by the Digital to Analog (D-A) Converter. When a "one" is present in the time slot, 45 relays K205 and K206 command the left arm to standby; likewise, when a "one" is present in the time slot, 46 relays K207 and K208 command the right arm to standby.

8-2.2. Auxiliary Control Unit

The added Auxiliary Control Unit is located on the right-hand portion of the sloped control panel (See figure 8-1, p. 121).

The Auxiliary Control Unit has a dual purpose. One is to detect a slew in the X and Y coordinates and relay this information to the D-A Converter. The other function is to offset the pens of either arm upon receipt of a signal from the D-A Converter.

Transistor networks N1, N2, and their associated circuitry comprise the slew detecting portion of this chassis. Since N1 and N2 are identical except for the inputs, only N1 is discussed. (See figures 8-2 and 8-3).

"Plotting Board ready" is applied to the D-A Converter through resistor R32. If arm #1 and arm #2 are at rest, there are no slew voltages. The slew signals are the output of the servo amplifiers. The amplitude of these signals is a function of the amount of slew. They are rectified by CR2

and CR3 and filtered by R11, R12, and C1. This signal is applied to one end of a voltage divider, R20, R21, and R22. R21 is the sensitivity adjustment. If the slew is large enough, a positive signal is applied to pin 2 of N1. CR6 clamps pin 2 a little above ground. The positive signal cuts off Q1. This applies a negative voltage to pin 6, which will put transistor Q2 into saturation. Q2 draws its current through the coil of K3. When K3 energizes, the contacts close (normally they are open), applying 0 volts to the D-A Converter. When the arm and pen complete their slew, the inputs drop. Q1 goes into conduction, cutting off Q2 and de-energizing K3 and again applying -27 volts to the D-A Converter. A slew in either arm applies 0 volts to the D-A Converter.

The offset function of this chassis involves relays K1, K2, and associated circuitry. Again K1 and K2 are identical; therefore only K1 will be discussed.

If no offset is desired, 0 volts are applied to pin "F", and K1 is back-biased through R2. The contacts of K1 are open, and no offset voltage is applied to DC amplifier #2. When -17 volts are applied to pin "F", K1 energizes and the plus reference is applied across R3 and R5. R5 is adjusted for the correct amount of offset. The voltage on the wiper of R5 is applied via R4 to the summing junction of DC amplifier #2.

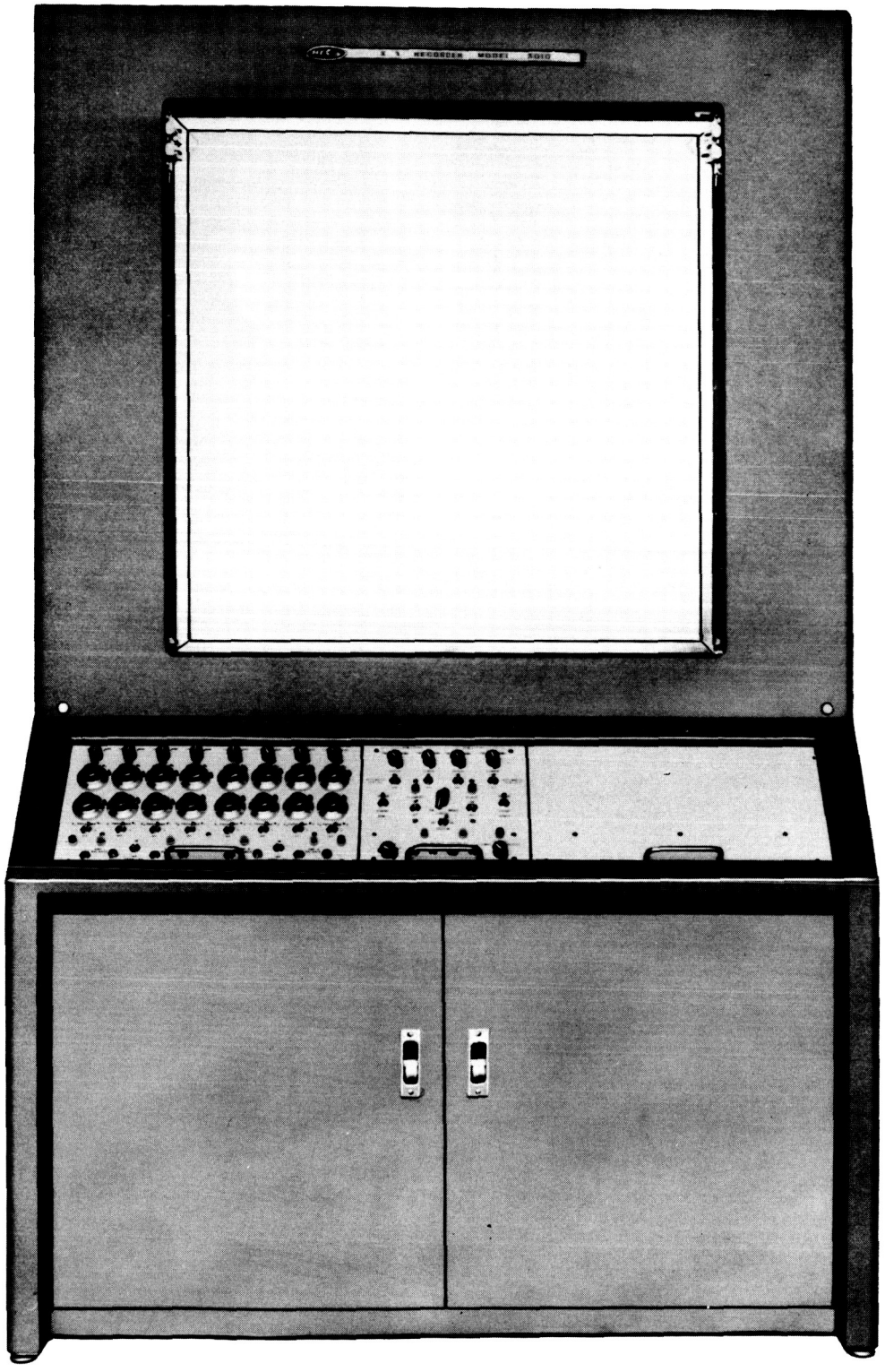


Figure 8-1. MEC Model 3010
X-Y Recorder Modified
per IBM Spec. #3218307

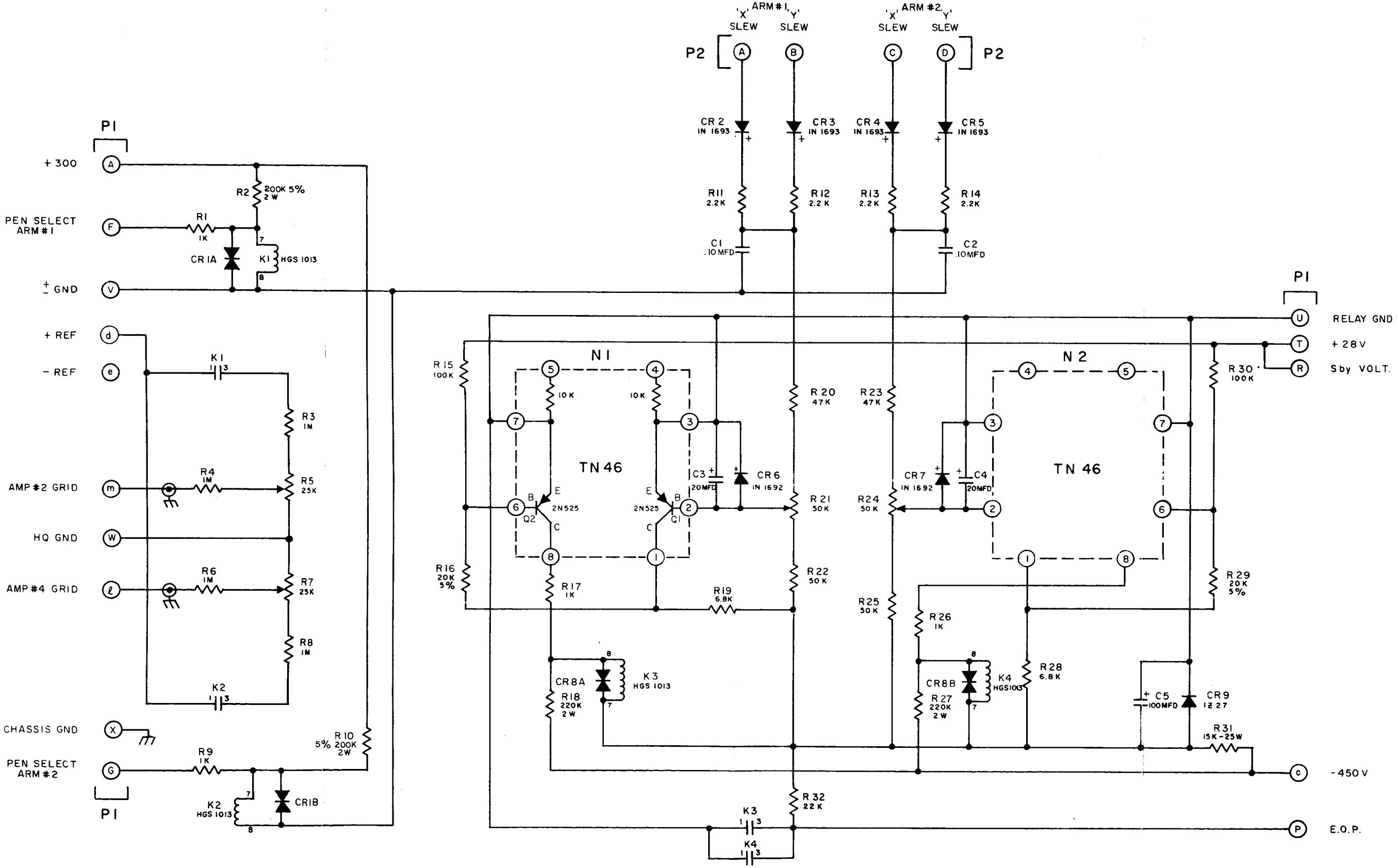
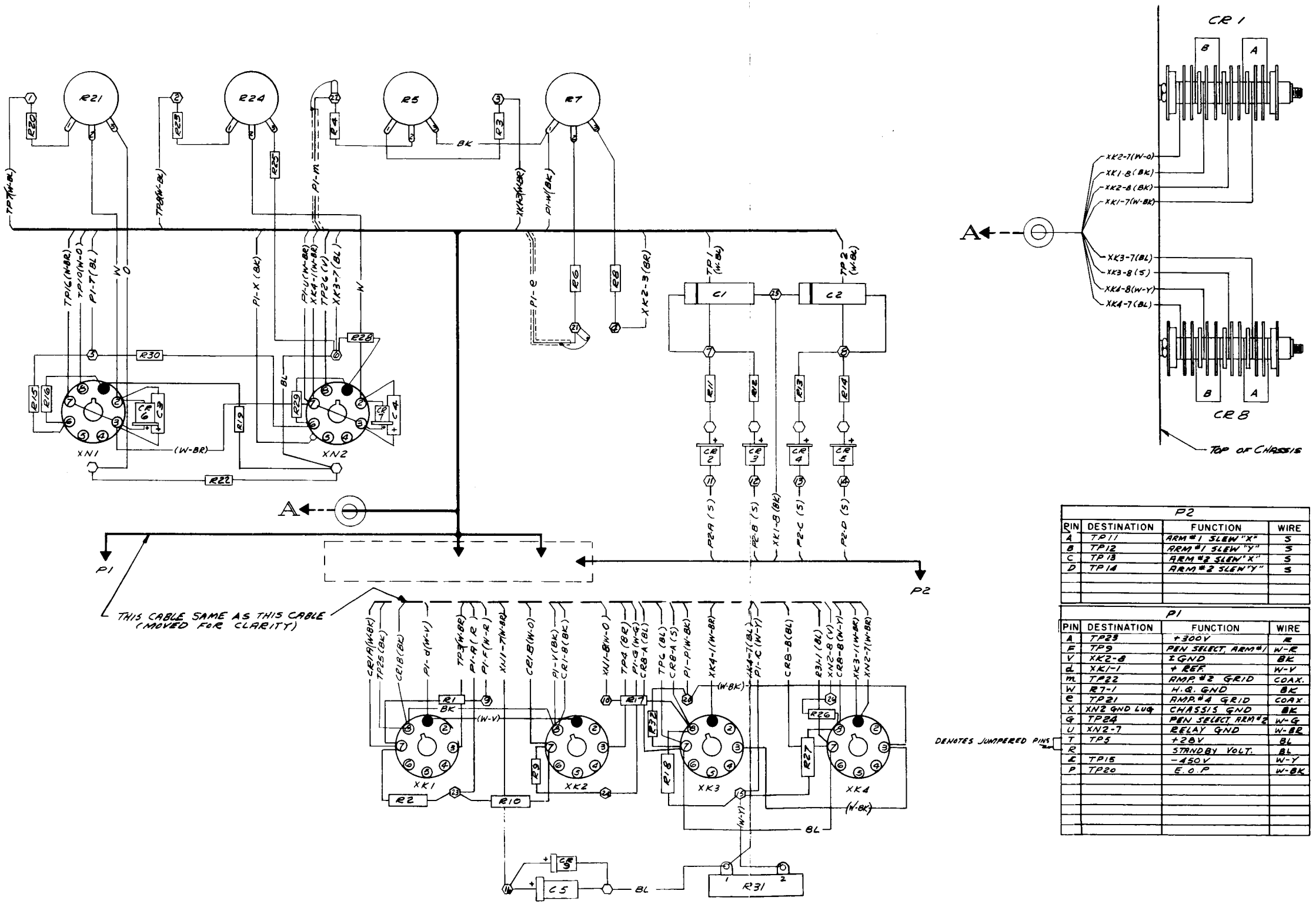


Figure 8-2. Schematic Diagram Auxiliary Control Unit



DENOTES JUMPERED PINS

P2

PIN	DESTINATION	FUNCTION	WIRE
A	TP11	ARM #1 SLEW "X"	S
B	TP12	ARM #1 SLEW "Y"	S
C	TP13	ARM #2 SLEW "X"	S
D	TP14	ARM #2 SLEW "Y"	S

P1

PIN	DESTINATION	FUNCTION	WIRE
A	TP23	+300V	R
F	TP9	PEN SELECT, ARM #1	W-R
V	XK2-8	I GND	BK
d	XK1-1	+ REF.	W-V
m	TP22	AMP. #2 GRID	COAX.
W	R7-1	H.Q. GND	BK
e	TP21	AMP. #4 GRID	COAX
X	XN2 GND LUG	CHASSIS GND	BK
G	TP24	PEN SELECT ARM #2	W-G
U	XN2-7	RELAY GND	W-BR
T	TP5	+28V	BL
R		STANDBY VOLT.	BL
C	TP15	-450V	W-Y
P	TP20	E.O.P	W-BK

Figure 8-3. Wiring Diagram
Auxiliary Control Unit